

**IN THE UNITED STATES DISTRICT COURT FOR
THE NORTHERN DISTRICT OF IOWA
NORTHERN DIVISION**

INTIRION CORPORATION,

Plaintiffs,

vs.

COLLEGE PRODUCTS, INC.,

Defendants.

Case No. 5:23-cv-04023-KEM

FIRST AMENDED COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff Intirion Corporation (“Plaintiff”), through its attorneys, for its First Amended Complaint for Patent Infringement against College Products, Inc. (“Defendant”) alleges the following:

I. NATURE OF THE ACTION

1. This is a civil action for patent infringement arising under the Patent Laws of the United States, 35 U.S.C. §§ 1, et seq., including §§ 271, 281, 284, and 285, and false advertising and unfair competition under the Lanham Act, 28 U.S.C. § 1125(a).

II. PARTIES

2. Plaintiff Intirion Corporation is a corporation organized and existing under the laws of Delaware and maintains its principal place of business at 2 Annette Road, Suite 3, Foxboro, MA 02035.

3. Defendant College Products is a corporation organized and existing under the laws of Iowa and on information and belief maintains its principal place of business at 1400 W. 1st Street, Sioux City, IA 51103.

III. JURISDICTION AND VENUE

4. This is an action for patent infringement, unfair competition/false advertising, and tortious interference, arising under the laws of the United States, in particular, 35 U.S.C. §§ 271, 281, 284, and 285, and 15 U.S.C. § 1125.

5. This Court has exclusive subject matter jurisdiction over this action for patent infringement pursuant to 28 USC § 1331 and § 1338(a).

6. This Court has specific and general personal jurisdiction over Defendant pursuant to due process and/or the Iowa Long Arm Statute, because Defendant is a corporation organized and existing under the laws of Iowa, maintains its principal place of business in this judicial district, and has committed acts giving rise to this action within Iowa and within this judicial district. The Court's exercise of jurisdiction over Defendant would not offend traditional notions of fair play and substantial justice because Defendant has established minimum contacts with the forum. For example, Defendant is a corporation organized and existing under the laws of Iowa and maintains its principal place of business in this judicial district. Additionally, on information and belief, Defendant has committed acts of infringement throughout Iowa and in this judicial district, by among other things, making, using, selling, leasing, and offering for sale or lease—products that infringe the asserted patents, directly or through intermediaries, as alleged herein.

7. Venue in the Northern District of Iowa is proper pursuant to 28 U.S.C. §§1391 and/or 1400(b). Venue is proper in this District under 28 USC § 1400(b) because Defendant is incorporated in Iowa, Defendant's registered agent is located in the Northern District of Iowa, Defendant has a regular and established place of business in this District, and Defendant has committed acts of patent infringement in this District. Moreover, Defendant has employees and/or agents physically present in this judicial district who perform acts for, on behalf of,

with the consent of, and/or under the direction of Defendant. Finally, Venue is proper in the Northern District of Iowa as acknowledged by Defendant in its motion to dismiss for lack of venue in this matter.

IV. PATENTS IN SUIT

8. Plaintiff is the owner by assignment of all right, title and interest in United States Patent Nos. 9,657,974; 9,791,206; 10,495,374; 11,274,876; 11,674,745; and 11,674,746 (collectively, the “Patents in Suit”), including all rights to enforce and prosecute all causes for actions rising under the Patents in Suit, the right to any remedies for infringement on the Patents in Suit, and the right to collect damages for all relevant times against infringers of the Patents in Suit. Accordingly, Plaintiff possesses the exclusive right and standing to prosecute the present action for infringement by Defendant of the Patents in Suit.

9. Each of the Patents in Suit relates to the construction, operation or features of a microwave/mini-refrigerator combination appliance. The patented appliance automatically coordinates the operation of the microwave and the refrigerator so that both cannot be operated at the same time, which would cause excessive power draw. The patented appliance includes a smoke sensor that shuts off the microwave cooking element when smoke is sensed inside the microwave. This avoids setting off building smoke alarms. The patented appliance also includes USB ports that can be used to charge electronic devices.

10. Plaintiff designs, manufactures, distributes, maintains, and services products incorporating the Patents in Suit throughout the United States, including within this judicial district.

11. Plaintiff complies with the notice provisions of 35 U.S.C. § 287, including by providing constructive notice of its patent via marking. For example, Plaintiff marks its products with a constructive marking notice and includes patent numbers at

<https://www.microfridge.com/patents/>.

12. The features of Plaintiff's patented combination appliance products are particularly useful in college dorms and in similar settings. This is because the patented features prevent excessive power draw that would otherwise trip electrical breakers and cause loss of power to the dorm rooms.

13. The features of Plaintiff's patented combination appliance also prevent unnecessary dormitory evacuations that would otherwise result from smoke detectors sensing smoke from burning food items in the microwave ovens. The inclusion of USB charging ports on Plaintiff's patented combination appliance also allows students to charge their phones and small electrical devices while keeping the limited number of electrical outlets in their dorm rooms available for other purposes.

14. Because of the benefits of the Patents in Suit, Plaintiff has agreements with colleges and universities throughout the United States, including with colleges and universities in this judicial district, to offer units incorporating the inventions of the Patents in Suit for sale or lease to students for use in their dorm rooms.

A. US Patent No. 9,657,974

15. US Patent No. 9,657,974 (the "974 Patent") is entitled "Multiple Linked Appliance With Auxiliary Outlet" and was duly issued by the United States Patent and Trademark Office to Plaintiff on May 23, 2017. A true and correct copy of the 974 Patent is attached hereto as Exhibit 1 and incorporated herein by reference.

B. US Patent No. 9,791,206

16. US Patent No. 9,791,206 (the "206 Patent") is entitled "Multiple Linked Appliance With Auxiliary Outlet" and was duly issued by the United States Patent and

Trademark Office to Plaintiff on October 17, 2017. A true and correct copy of the 206 Patent is attached hereto as Exhibit 2 and incorporated herein by reference.

C. US Patent No. 11,274,876

17. US Patent No. 11,274,876 (the “876 Patent”) is entitled “Multiple Linked Appliance With Auxiliary Outlet” and was duly issued to Plaintiff by the United States Patent and Trademark Office on March 15, 2022. A true and correct copy of the 876 Patent is attached hereto as Exhibit 3 and incorporated herein by reference.

D. US Patent No. 10,495,374

18. US Patent No. 10,495,374 (the “374 Patent”) is entitled “Multiple Linked Appliance With Auxiliary Outlet” and was duly issued by the United States Patent and Trademark Office to Plaintiff on December 3, 2019. A true and correct copy of the 374 Patent is attached hereto as Exhibit 4 and incorporated herein by reference.

E. US Patent No. 11,674,745

19. US Patent No. 11,674,745 (the “745 Patent”) is entitled “Multiple Linked Appliance With Auxiliary Outlet” and was duly issued by the United States Patent and Trademark Office to Plaintiff on June 13, 2023. A true and correct copy of the ‘745 Patent is attached hereto as Exhibit 5 and incorporated herein by reference.

F. US Patent No. 11,674,746

20. US Patent No. 11,674,746 (the “746 Patent”) is entitled “Multiple Linked Appliance With Auxiliary Outlet” and was duly issued by the United States Patent and Trademark Office to Plaintiff on June 13, 2023. A true and correct copy of the ‘746 Patent is attached hereto as Exhibit 6 and incorporated herein by reference.

V. THE ACCUSED PRODUCTS

21. Defendant makes, sells, offers for sale, leases, offers for lease, and/or

distributes within the United States, including within this judicial district, products such as, but not limited to, microwave, mini refrigerators, and/or microwave and refrigerator combinations that are sold under the trademarks MicroChill and/or MicroChill 3.2 (the “Accused Products”).

22. The Accused Products infringe the Patents in Suit. The Defendant has copied Plaintiff’s patented features. Like the Plaintiff’s patented combination appliance, the Accused Products are a combination microwave and mini-refrigerator appliance that includes power control circuitry that avoids excessive power draw by automatically preventing both the microwave and refrigerator from operating at the same time. Defendant also copied Plaintiff’s patented smoke sensor technology that stops operation of the microwave cooking element whenever smoke is sensed, to avoid tripping smoke detectors and unnecessary dormitory evacuations. Defendant also copied Plaintiff’s patented USB charging port feature on the front of the microwave oven.

23. The Accused Products are explicitly marketed to the public, including Plaintiff’s customers, as providing the very features that are protected by the Patents in Suit and for the very same purpose – to provide a safe and reliable microwave and mini-refrigerator combination appliance. *See* Exhibit 7. Consequently, Defendant’s sales and leases of the Accused Products directly competes with and takes business from Plaintiff.

24. Defendant solicits and enters into agreements to provide the Accused Products to colleges and universities throughout the United States, including, upon information and belief, within this judicial district. Under the agreements and hoped for agreements with these colleges and universities, the Accused Products are approved for use in dorm rooms, and students buy or lease the Accused Products. Defendant directly installs the Accused Products in the dorm rooms. Defendant also directly provides any necessary maintenance or warranty

services for the Accused Products in such dorm rooms. In exchange, Defendant receives all or a portion of the proceeds generated by selling or leasing the Accused Products to the students.

25. Defendant's infringement occurred with knowledge of the Asserted Patents, and thus has been and will continue to be willful and deliberate.

26. Defendant's conduct constitutes willful and deliberate infringement, which entitles Plaintiff to enhanced damages under 35 U.S.C. § 285.

VI. DEFENDANT'S FALSE AND MISLEADING STATEMENTS

27. During Defendant's solicitation of agreements with colleges and universities throughout the United States, Defendant has made one or more representations regarding the quality, specification, safety, or capability of the Accused Products, as well as statements regarding Defendant's capabilities, staffing, or "green" initiatives.

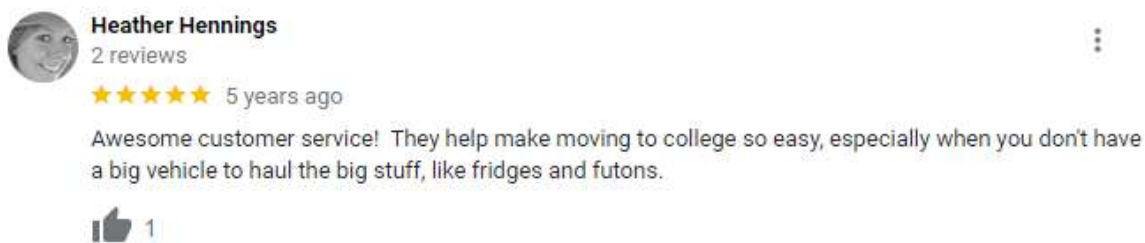
28. For example, in Defendant's solicitation of agreements with Clemson University and Arkansas Tech University, Defendant represented to Clemson University and Arkansas Tech University that the Accused Products are CEE certified or CEE Advanced Tiered certified. Upon information and belief, the Accused Products are not (and have never been) CEE or CEE Advanced Tiered certified.

29. Defendant further has claimed, in its solicitation of agreements with San Diego State University, that its combination units switch off power to the USB port when the microwave oven is in use. This despite Defendant's counsel's assertions *in this litigation* that its USB ports remain on when the microwave oven is in use.

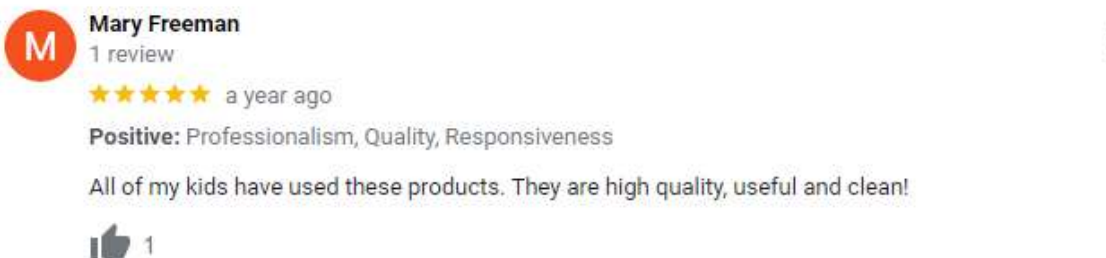
30. Defendant has further claimed in its customer proposals and agreements that its combination unit is UL listed specifically for use in combination (e.g., is a UL certified combination appliance). Upon information and belief, despite Defendant's UL certifications, Defendant knowingly sells and/or leases the Accused Product in a manner that is inconsistent

with UL combination certifications, including by selling and/or leasing the Accused Products separately or such that they are assembled by the end user, or otherwise not assembled in a manner consistent with the requirements of the UL combination certification.

31. Defendant also leaves misleading reviews on its own products and services in a ploy to boost their ratings and suppress consumer's negative reviews. For example, Heather Hennings, wife of Defendant's CEO Eric Hennings, left a positive Google review on College Products' services without identifying herself as linked to College Products or disclaiming that she was reviewing College Products on behalf of College Products:



32. Mary Freeman, currently employed by College Products in a Marketing & Customer Relations role, has also reviewed College Products without identifying her link to the company or disclaiming that she was reviewing on behalf of the company all in what Intirion understands is an attempt to artificially inflate Defendant's online review rating:



33. Austin Feddersen, also currently employed by College Products, left a similarly positive review without disclosing his relationship with College Products:



Austin Feddersen

★★★★★ a year ago

Services: Delivery, Couches/sofas, Furniture assembly

Positive: Punctuality, Quality

34. Defendant has also claimed in representations to universities and colleges that its Smart Stop Internal Smoke Sensor is “safe” and will turn off power to the microwave “at the first detection of smoke.”

35. The Accused Products, however, do not perform as advertised to prospective purchasers. Upon information and belief, the Smart Stop Internal Smoke Sensors do not turn off the microwave of the Accused Products until after smoke is both visible and olfactible. Moreover, according to Defendant’s representations *in this litigation*, the Smart Stop Internal Smoke Sensors are disabled for a period of at least 90 seconds after an initial smoke sensor trip—in effect, allowing the microwave to run with extreme smoke or even *with an ongoing fire inside* for at least 90 seconds.

36. Defendants have claimed in representations to many universities that its Smart Stop Internal Smoke Sensor will “eliminate burnt popcorn” and false fire alarms by turning off the microwave. Upon information and belief, Defendants’ smoke sensor does not turn off the microwave until well after smoke is present in the microwave. In the example of popcorn, upon information and belief, Defendant’s smoke sensor fails to perform as Defendant represents, and only turns the microwave off well after popcorn is already burnt, after a large amount of smoke has filled the room in which the microwave is located.

37. Upon information and belief, Defendant made these false and misleading statements in its bids and advertisements in an effort to draw in business and take business

away from Plaintiff.

38. Indeed, Defendant's misrepresentations were made in bids to universities and colleges Plaintiff also submits bids to, and Defendant's misrepresentations appear to be made to make the Accused Products more competitive against Plaintiff's products and have had the effect of forcing Plaintiff to lower its prices to compete.

39. Plaintiff is aware of at least one bid, the San Diego State University bid, where Defendant made misrepresentations in the bid to compete with Plaintiff, and Defendant ultimately won the bid.

VII. COUNT 1: INFRINGEMENT OF THE '974 PATENT

40. Plaintiff restates Paragraphs 1 through 39 as if fully rewritten herein.

41. Defendant has, under 35 USC § 271(a) directly infringed, and continues to directly infringe, literally and/or under the doctrine of equivalents, one or more claims, including without limitation at least claims 1, 7 and 12 of the '974 Patent, by making, using, offering to sell, selling, leasing, offering to lease, and/or importing into the United States, including within this judicial district, the Accused Products.

42. Defendant continues to directly infringe at least one claim of the '974 Patent, literally or under the doctrine of equivalents, by making, using, selling, offering for sale, selling, leasing, offering for lease, importing, and/or distributing the Accused Products in the United States, including within this judicial district, without Plaintiff's authority.

43. Defendant has sold and/or leased the Accused Products to educational institutions and individuals throughout the United States and in the State of Iowa, including in this judicial district, and has induced others to infringe the '974 Patent by using the Accused Products.

44. Defendant has received notice and actual or constructive knowledge of the '974

Patent since at least the date of service of the Original Complaint.

45. Defendant has engaged in infringement by making, using, offering to sell, selling, leasing, offering to lease, and importing the Accused Products into the United States, including in this judicial district, despite having knowledge that the Accused Products infringe the '974 Patent.

46. Since at least the date of service of the Original Complaint, through its actions, Defendant has contributed to the infringement of the '974 Patent by having others sell, offer for sale, selling, leasing, offering for lease, or use the Accused Products throughout the United States, including within this judicial district, with knowledge that the Accused Products infringe the '974 Patent.

47. The Accused Products are especially made or adapted for infringing the '974 Patent and have no substantial non-infringing use. For example, in view of the preceding Paragraphs, the Accused Products contain functionality which is material to at least one claim of the '974 Patent.

48. Plaintiff has been damaged as a result of Defendant's infringement. Upon information and belief, Defendant will continue to infringe one or more claims of the '974 Patent unless and until they are enjoined by this Court.

49. Defendant had knowledge of the '974 patent prior to the filing of this First Amended Complaint. Upon information and belief, Defendant has willfully infringed, and continues to willfully infringe, the '974 patent, which entitles Plaintiff to enhanced damages under 35 U.S.C. § 285. For example, Defendant undertook and continues their infringing actions despite an objectively high likelihood that such activities infringe the '974 Patent, which has been duly issued by the PTO and is presumed valid. Moreover, for example, since

at least the filing of the Original Complaint, Defendant has been aware of an objectively high likelihood that their actions constituted and continue to constitute infringement of the '974 Patent and that the '974 Patent is valid. On information and belief, Defendant could not reasonably, subjectively believe that its actions do not constitute infringement of the '974 patent. Despite that knowledge and subjective belief, and the objectively high likelihood that its actions constitute infringement, Defendant has continued its infringing activities. As such, Defendant has willfully infringed and/or will continue to willfully infringe the '974 patent.

VIII. COUNT 2: INFRINGEMENT OF THE '206 PATENT

50. Plaintiff restates Paragraphs 1 through 49 as if fully rewritten herein.

51. Defendant has, under 35 USC § 271(a) directly infringed, and continues to directly infringe, literally and/or under the doctrine of equivalents, one or more claims, including without limitation at least claims 9, 10, 11 and 12 of the '206 Patent, by making, using, offering to sell, selling, leasing, offering to lease, and/or importing into the United States, including within this judicial district, the Accused Products.

52. Defendant continues to directly infringe at least one claim of the '206 Patent, literally or under the doctrine of equivalents, by making, using, selling, offering for sale, leasing, offering for lease, importing, and/or distributing the Accused Products in the United States, including within this judicial district, without Plaintiff's authority.

53. Defendant has sold and/or leased the Accused Products to educational institutions and individuals throughout the United States and in the State of Iowa, including in this judicial district, and has induced others to infringe the '206 Patent by using the Accused Products.

54. Defendant has received notice and actual or constructive knowledge of the '206 Patent since at least the date of service of the Original Complaint.

55. Defendant has engaged in infringement by making, using, offering to sell, selling, leasing, offering to lease, and importing the Accused Products into the United States, including in this judicial district, despite having knowledge that the Accused Products infringe the '206 Patent.

56. Since at least the date of service of the Original Complaint, through its actions, Defendant has contributed to the infringement of the '206 Patent by having others sell, selling, offer for sale, lease, offering to lease, or use the Accused Products throughout the United States, including within this judicial district, with knowledge that the Accused Products infringe the '206 Patent.

57. The Accused Products are especially made or adapted for infringing the '206 Patent and have no substantial non-infringing use. For example, in view of the preceding Paragraphs, the Accused Products contain functionality which is material to at least one claim of the '206 Patent.

58. Plaintiff has been damaged as a result of Defendant's infringement. Upon information and belief, Defendant will continue to infringe one or more claims of the '206 Patent unless and until they are enjoined by this Court.

59. Defendant had knowledge of the '206 patent prior to the filing of this First Amended Complaint. Upon information and belief, Defendant has willfully infringed, and continues to willfully infringe, the '206 patent, which entitles Plaintiff to enhanced damages under 35 U.S.C. § 285. For example, Defendant undertook and continues their infringing actions despite an objectively high likelihood that such activities infringe the '206 Patent, which has been duly issued by the PTO and is presumed valid. Moreover, for example, since at least the filing of the Original Complaint, Defendant has been aware of an objectively high

likelihood that their actions constituted and continue to constitute infringement of the '206 Patent and that the '206 Patent is valid. On information and belief, Defendant could not reasonably, subjectively believe that its actions do not constitute infringement of the '206 patent. Despite that knowledge and subjective belief, and the objectively high likelihood that its actions constitute infringement, Defendant has continued its infringing activities. As such, Defendant has willfully infringed and/or will continue to willfully infringe the '206 patent.

IX. COUNT 3: INFRINGEMENT OF THE '876 PATENT

60. Plaintiff restates Paragraphs 1 through 59 as if fully rewritten herein.

61. Defendant has, under 35 USC § 271(a) directly infringed, and continues to directly infringe, literally and/or under the doctrine of equivalents, one or more claims, including without limitation at least claims 1, 21, 25, 26, and 28 of the '876 Patent, by making, using, offering to sell, selling, leasing, offering to lease, and/or importing the Accused Products into the United States, including within this judicial district.

62. Defendant continues to directly infringe at least one claim of the '876 Patent, literally or under the doctrine of equivalents, by making, using, selling, offering for sale, leasing, offering for lease, importing, and/or distributing the Accused Products in the United States, including within this judicial district, without Plaintiff's authority.

63. Defendant has sold and/or leased the Accused Products to educational institutions and individuals throughout the United States and in the State of Iowa, including in this judicial district, and has induced others to infringe the '876 Patent by using the Accused Products.

64. Defendant has received notice and had actual or constructive knowledge of the '876 Patent since at least the date of service of the Original Complaint.

65. Defendant has engaged in infringement by making, using, offering to sell,

selling, offering to lease, leasing, and importing into the United States, including in this judicial district, the Accused Products despite having knowledge that the Accused Products infringe the '876 Patent.

66. Since at least the date of service of the Original Complaint, through its actions, Defendants have contributed to the infringement of the '876 Patent by having others sell, offer for sale, leasing, offering to lease, or use the Accused Products throughout the United States, including within this judicial district, with knowledge that the Accused Products infringe the '876 Patent.

67. The Accused Products are especially made or adapted for infringing the '876 Patent and have no substantial non-infringing use. For example, in view of the preceding Paragraphs, the Accused Products contain functionality which is material to at least one claim of the '876 Patent.

68. Plaintiff has been damaged as a result of Defendant's infringement. Upon information and belief, Defendant will continue to infringe one or more claims of the '876 Patent unless and until it is enjoined by this Court.

69. Defendant had knowledge of the '876 patent prior to the filing of this First Amended Complaint. Upon information and belief, Defendant has willfully infringed, and continues to willfully infringe, the '876 patent, which entitles Plaintiff to enhanced damages under 35 U.S.C. § 285. For example, Defendant undertook and continues their infringing actions despite an objectively high likelihood that such activities infringe the '876 Patent, which has been duly issued by the PTO and is presumed valid. Moreover, for example, since at least the filing of the Original Complaint, Defendant has been aware of an objectively high likelihood that its actions constituted and continue to constitute infringement of the '876 Patent

and that the '876 Patent is valid. On information and belief, Defendant could not reasonably, subjectively believe that its actions do not constitute infringement of the '876 patent. Despite that knowledge and subjective belief, and the objectively high likelihood that its actions constitute infringement, Defendant has continued its infringing activities. As such, Defendant has willfully infringed and/or will continue to willfully infringe the '876 patent.

X. COUNT 4: INFRINGEMENT OF THE '374 PATENT

70. Plaintiff restates Paragraphs 1 through 69 as if fully rewritten herein.

71. Defendant has, under 35 USC § 271(a) directly infringed, and continues to directly infringe, literally and/or under the doctrine of equivalents, one or more claims, including without limitation at least claims 9, 10, 11, 12, 17, 18, 19, and 20 of the '374 Patent, by making, using, offering to sell, selling, leasing, offering to lease, and/or importing into the United States, including within this judicial district, the Accused Products.

72. Defendant continues to directly infringe at least one claim of the '374 Patent, literally or under the doctrine of equivalents, by making, using, selling, offering for sale, leasing, offering for lease, importing, and/or distributing the Accused Products in the United States, including within this judicial district, without Plaintiff's authority.

73. Defendant has sold and/or leased the Accused Products to educational institutions and individuals throughout the United States and in the State of Iowa, including in this judicial district, and has induced others to infringe the '374 Patent by using the Accused Products.

74. Defendant has received notice and actual or constructive knowledge of the '374 Patent since at least the date of service of the Original Complaint.

75. Defendant has engaged in infringement by making, using, offering to sell, selling, leasing, offering to lease, and importing the Accused Products into the United States,

including in this judicial district, despite having knowledge that the Accused Products infringe the '374 Patent.

76. Since at least the date of service of the Original Complaint, through its actions, Defendant has contributed to the infringement of the '374 Patent by having others sell, offer for sale, selling, leasing, offering to lease, or use the Accused Products throughout the United States, including within this judicial district, with knowledge that the Accused Products infringe the 374 Patent.

77. The Accused Products are especially made or adapted for infringing the '374 Patent and have no substantial non-infringing use. For example, in view of the preceding Paragraphs, the Accused Products contain functionality which is material to at least one claim of the '374 Patent.

78. Plaintiff has been damaged as a result of Defendant's infringement. Upon information and belief, Defendant will continue to infringe one or more claims of the '374 Patent unless and until they are enjoined by this Court.

79. Defendant had knowledge of the '374 patent prior to the filing of this First Amended Complaint. Upon information and belief, Defendant has willfully infringed, and continues to willfully infringe, the '374 patent, which entitles Plaintiff to enhanced damages under 35 U.S.C. § 285. For example, Defendant undertook and continues their infringing actions despite an objectively high likelihood that such activities infringe the '374 Patent, which has been duly issued by the PTO and is presumed valid. Moreover, for example, since at least the filing of the Original Complaint, Defendant has been aware of an objectively high likelihood that their actions constituted and continue to constitute infringement of the '374 Patent and that the '374 Patent is valid. On information and belief, Defendant could not

reasonably, subjectively believe that its actions do not constitute infringement of the '374 patent. Despite that knowledge and subjective belief, and the objectively high likelihood that its actions constitute infringement, Defendant has continued its infringing activities. As such, Defendant has willfully infringed and/or will continue to willfully infringe the '374 patent.

XI. COUNT 5: INFRINGEMENT OF THE '745 PATENT

80. Plaintiff restates Paragraphs 1 through 79 as if fully rewritten herein.

81. Defendant has, under 35 USC § 271(a) directly infringed, and continues to directly infringe, literally and/or under the doctrine of equivalents, one or more claims, including without limitation at least claims 1, 12, 13, 14, 15, 19, 20, 22, 23, 24, 25, and 26 of the '745 Patent, by making, using, offering to sell, selling, leasing, offering to lease, and/or importing into the United States, including within this judicial district, the Accused Products.

82. Defendant continues to directly infringe at least one claim of the '745 Patent, literally or under the doctrine of equivalents, by making, using, selling, offering for sale, selling, leasing, offering for lease, importing, and/or distributing the Accused Products in the United States, including within this judicial district, without Plaintiff's authority.

83. Defendant has sold and/or leased the Accused Products to educational institutions and individuals throughout the United States and in the State of Iowa, including in this judicial district, and has induced others to infringe the '745 Patent by using the Accused Products.

84. Defendant has received notice and actual or constructive knowledge of the '745 Patent since at least the date of service of this First Amended Complaint.

85. Defendant has engaged in infringement by making, using, offering to sell, selling, leasing, offering to lease, and importing the Accused Products into the United States, including in this judicial district, despite having knowledge that the Accused Products infringe

the '745 Patent.

86. Since at least the date of service of this First Amended Complaint, through its actions, Defendant has contributed to the infringement of the '745 Patent by having others sell, offer for sale, selling, leasing, offering for lease, or use the Accused Products throughout the United States, including within this judicial district, with knowledge that the Accused Products infringe the '745 Patent.

87. The Accused Products are especially made or adapted for infringing the '745 Patent and have no substantial non-infringing use. For example, in view of the preceding Paragraphs, the Accused Products contain functionality which is material to at least one claim of the '745 Patent.

88. Plaintiff has been damaged as a result of Defendant's infringement. Upon information and belief, Defendant will continue to infringe one or more claims of the '745 Patent unless and until they are enjoined by this Court.

89. Upon information and belief, Defendant had knowledge of the '745 patent prior to the filing of this First Amended Complaint. Upon information and belief, Defendant has willfully infringed, and continues to willfully infringe, the '745 patent, which entitles Plaintiff to enhanced damages under 35 U.S.C. § 285. For example, Defendant undertook and continues their infringing actions despite an objectively high likelihood that such activities infringe the '745 Patent, which has been duly issued by the PTO and is presumed valid. Moreover, for example, since at least prior to the filing of the First Amended Complaint, Defendant has been aware of an objectively high likelihood that their actions constituted and continue to constitute infringement of the '745 Patent and that the '745 Patent is valid. On information and belief, Defendant could not reasonably, subjectively believe that

its actions do not constitute infringement of the '745 patent. Despite that knowledge and subjective belief, and the objectively high likelihood that its actions constitute infringement, Defendant has continued its infringing activities. As such, Defendant has willfully infringed and/or will continue to willfully infringe the '745 patent.

XII. COUNT 6: INFRINGEMENT OF THE '746 PATENT

90. Plaintiff restates Paragraphs 1 through 89 as if fully rewritten herein.

91. Defendant has, under 35 USC § 271(a) directly infringed, and continues to directly infringe, literally and/or under the doctrine of equivalents, one or more claims, including without limitation at least claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 20, 21, 22, 23, 24, and 25 of the '746 Patent, by making, using, offering to sell, selling, leasing, offering to lease, and/or importing into the United States, including within this judicial district, the Accused Products.

92. Defendant continues to directly infringe at least one claim of the '746 Patent, literally or under the doctrine of equivalents, by making, using, selling, offering for sale, selling, leasing, offering for lease, importing, and/or distributing the Accused Products in the United States, including within this judicial district, without Plaintiff's authority.

93. Defendant has sold and/or leased the Accused Products to educational institutions and individuals throughout the United States and in the State of Iowa, including in this judicial district, and has induced others to infringe the '746 Patent by using the Accused Products.

94. Defendant has received notice and actual or constructive knowledge of the '746 Patent since at least the date of service of this First Amended Complaint.

95. Defendant has engaged in infringement by making, using, offering to sell, selling, leasing, offering to lease, and importing the Accused Products into the United States,

including in this judicial district, despite having knowledge that the Accused Products infringe the '746 Patent.

96. Since at least the date of service of this First Amended Complaint, through its actions, Defendant has contributed to the infringement of the '746 Patent by having others sell, offer for sale, selling, leasing, offering for lease, or use the Accused Products throughout the United States, including within this judicial district, with knowledge that the Accused Products infringe the '746 Patent.

97. The Accused Products are especially made or adapted for infringing the '746 Patent and have no substantial non-infringing use. For example, in view of the preceding Paragraphs, the Accused Products contain functionality which is material to at least one claim of the '746 Patent.

98. Plaintiff has been damaged as a result of Defendant's infringement. Upon information and belief, Defendant will continue to infringe one or more claims of the '746 Patent unless and until they are enjoined by this Court.

99. Defendant had knowledge of the '746 patent prior to the filing of this First Amended Complaint. Upon information and belief, Defendant has willfully infringed, and continues to willfully infringe, the '746 patent, which entitles Plaintiff to enhanced damages under 35 U.S.C. § 285. For example, Defendant undertook and continues their infringing actions despite an objectively high likelihood that such activities infringe the '746 Patent, which has been duly issued by the PTO and is presumed valid. Moreover, for example, since at least prior to the filing of the First Amended Complaint, Defendant has been aware of an objectively high likelihood that their actions constituted and continue to constitute infringement of the '746 Patent and that the '746 Patent is valid. On information and belief,

Defendant could not reasonably, subjectively believe that its actions do not constitute infringement of the '746 patent. Despite that knowledge and subjective belief, and the objectively high likelihood that its actions constitute infringement, Defendant has continued its infringing activities. As such, Defendant has willfully infringed and/or will continue to willfully infringe the '746 patent.

XIII. COUNT 5: FALSE ADVERTISING AND UNFAIR COMPETITION UNDER THE LANHAM ACT

100. Plaintiff restates Paragraphs 1 through 99 as if fully rewritten herein.

101. Defendant's false and misleading claims regarding the Accused Product's functionality, safety, or certifications, and misleading self-reviews of its own company constitute false advertising and unfair competition, in violation of Section 43(a) of the Lanham Act, 15 U.S.C. § 1125(a).

102. Defendant made its false and misleading claims in commercial advertisements, bids, and even in reviews of its own business, and caused its statements to enter interstate commerce.

103. Defendant's false and misleading claims, deceived, or were likely to deceive, a substantial segment of the consumers, colleges, and universities who purchase or lease their combination microwave/minifridges.

104. Defendant's false and misleading claims were material and likely to influence the purchasing decisions of consumers, universities, and colleges.

105. Defendant's actions have damaged, and will continue to damage, Intirion, including without limitation injury to Intirion's commercial interest in reputation and sales by, among other things, causing consumers, universities, and colleges to purchase Defendant's Accused Products instead of Intirion's combination microwave/minifridge based on one or

more of Defendant's false representations of the Accused Products' functionality, safety, or certifications, or misleading self-reviews of its own company.

106. Defendant's actions have also resulted in extensive price erosion in the market, as Defendant is able to offer its products for sale at lower price points.

107. Upon information and belief, Defendant's actions have been willful and in bad faith, making this an exceptional case under 15 U.S.C. § 1117(a).

108. As a result of Defendant's wrongful conduct, Plaintiff is entitled to injunctive relief, damages in an amount to be proven at trial, trebled where appropriate, and recovery of all reasonable attorneys' fees and costs incurred herein.

XIV. COUNT 6: TORTIOUS INTERFERENCE WITH PROSPECTIVE BUSINESS

109. Plaintiff restates Paragraphs 1 through 108 as if fully rewritten herein.

110. Plaintiff and Defendant both submitted bids to be suppliers to various universities and colleges, including at least San Diego State University.

111. Upon information and belief, Defendant knew Plaintiff was submitting bids to the same universities and colleges as Defendant.

112. Upon information and belief, Defendant knowingly made material misrepresentations regarding its products, its certifications, and/or itself to better compete against Plaintiff's products, stop Plaintiff from winning the bids, and win the bids for itself.

113. Plaintiff at least did not win the San Diego State University bid because of Defendant's improper interference consisting of false and misleading statements made during the bid process. Upon information and belief, Defendant has won additional work that Plaintiff submitted bids for.

114. As a result of Defendant's wrongful conduct, Plaintiff has been damaged in an amount to be proven at trial.

XV. PRAYER FOR RELIEF

WHEREFORE, Plaintiff respectfully requests the following relief:

- A. A judgment that Defendant has directly infringed the Patents in Suit, either literally and/or under the doctrine of equivalents, and continues to directly infringe such Patents in Suit;
- B. A judgment and order requiring Defendant to pay Plaintiff damages for infringement of the Patents in Suit under 35 U.S.C. § 284;
- C. A judgment and order that Defendant has willfully infringed the Patents in Suit and an award of treble damages to Plaintiff;
- D. A judgment that this is an exceptional case within the meaning of 35 U.S.C. § 285 and Plaintiff is therefore entitled to its reasonable attorneys' fees incurred in prosecuting this action;
- E. A judgment that Defendant be permanently enjoined from directly or indirectly using in commerce or disseminating to the marketplace any materials, promotional materials, advertising, bids, or other materials containing any false and misleading statements described in this First Amended Complaint, or any advertising or labeling which communicates similar false and misleading messages;
- F. Defendant be ordered to issue corrective advertising and corrective notifications to their customers, including colleges and universities that awarded business to Defendant based on Defendant's false and misleading statements;
- G. Defendant be ordered to file with this Court and to serve upon Plaintiff within thirty (30) days after the entry and service on Defendant of an injunction, a

report in writing and under oath setting forth in detail the manner in which Defendant has complied with the injunction;

- H. A monetary award of all of Defendant's profits derived from its false and misleading advertising, to be trebled in accordance with 15 U.S.C. § 1117;
- I. A monetary award of all damages Plaintiff has sustained from Defendant's false advertising and improper interference, including lost profits and lost sales, trebled in accordance with 15 U.S.C. § 1117;
- J. A judgment and order requiring Defendant to pay Plaintiff pre- and post-judgment interest on the damages awarded;
- K. A judgment and order awarding a compulsory ongoing royalty be paid by Defendant to Plaintiff if no permanent injunction is granted;
- L. A judgment and order awarding Plaintiff costs and any disbursements associated with bringing this action;
- M. A judgment granting a permanent injunction that restrains and enjoins Defendant, its officers, directors, employees, agents, subsidiaries, successors, assigns and all those in privity with them, or acting in concert with them, from directly or indirectly infringing the Patents in Suit; and
- N. Such other and further relief as the Court deems just and equitable under law or in equity.

JURY TRIAL DEMANDED

Plaintiff respectfully requests a trial by jury on all issues so triable.

June 28, 2023

Respectfully submitted,

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**Attorneys for Plaintiff Intirion
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CERTIFICATE OF SERVICE

I hereby certify that on June 28, 2023, I electronically filed the foregoing document with the Clerk of the Court using the CM/ECF system, which will send a notice of electronic filing to all counsel of record registered with CM/ECF.

/s/ Erica Palmer

EXHIBIT 1

US Patent No. 9,657,974



US009657974B2

(12) **United States Patent**
Emma

(10) **Patent No.:** **US 9,657,974 B2**
(45) **Date of Patent:** ***May 23, 2017**

(54) **MULTIPLE LINKED APPLIANCE WITH
AUXILIARY OUTLET**

USPC 219/482, 483, 485, 488, 679, 695, 702,
219/716, 717, 718, 723, 720, 715, 678
See application file for complete search history.

(71) Applicant: **Intirion Corporation**, Walpole, MA
(US)

(56) **References Cited**

(72) Inventor: **Phillip Emma**, Topsfield, MA (US)

U.S. PATENT DOCUMENTS

(73) Assignee: **Intirion Corporation**, Walpole, MA
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 284 days.

This patent is subject to a terminal dis-
claimer.

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307/39

(21) Appl. No.: **14/262,290**

(22) Filed: **Apr. 25, 2014**

(65) **Prior Publication Data**

US 2014/0251982 A1 Sep. 11, 2014

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/317,632,
filed on Dec. 23, 2008, now Pat. No. 8,742,304.

(60) Provisional application No. 61/009,419, filed on Dec.
28, 2007.

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Primary Examiner — Hung D Nguyen

(74) *Attorney, Agent, or Firm* — Ralph E. Jocke; Walker
& Jocke

(51) **Int. Cl.**
H05B 6/64 (2006.01)
H05B 6/66 (2006.01)
H05B 6/68 (2006.01)
F25B 29/00 (2006.01)

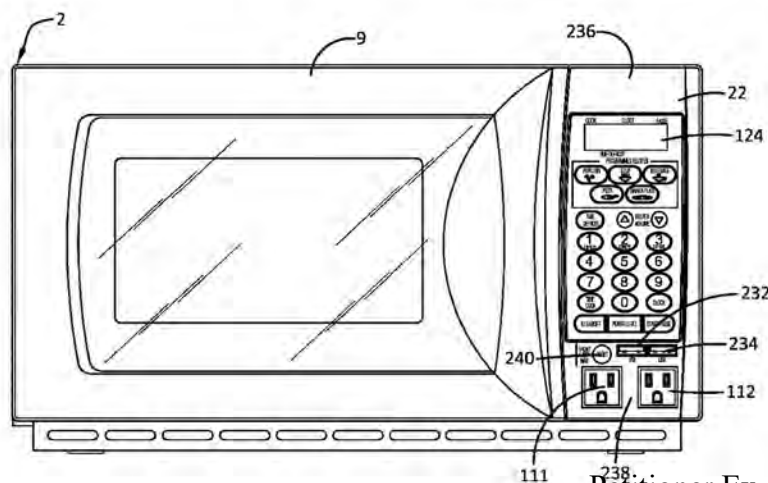
(52) **U.S. Cl.**
CPC **F25B 29/00** (2013.01); **H05B 6/68**
(2013.01)

(58) **Field of Classification Search**
CPC . H05B 6/68; H05B 6/808; H05B 6/66; H05B
6/645; F25B 29/00

(57) **ABSTRACT**

A combination microwave and refrigerator system is constructed having a single plug input supply. The microwave oven is adapted to provide power to a refrigerator, and to auxiliary receptacles adapted for low power operation. The current to the low power receptacles and the refrigerator is controlled by the controller for the microwave oven according to the duty cycles of the connected appliances to avoid overload conditions.

22 Claims, 20 Drawing Sheets



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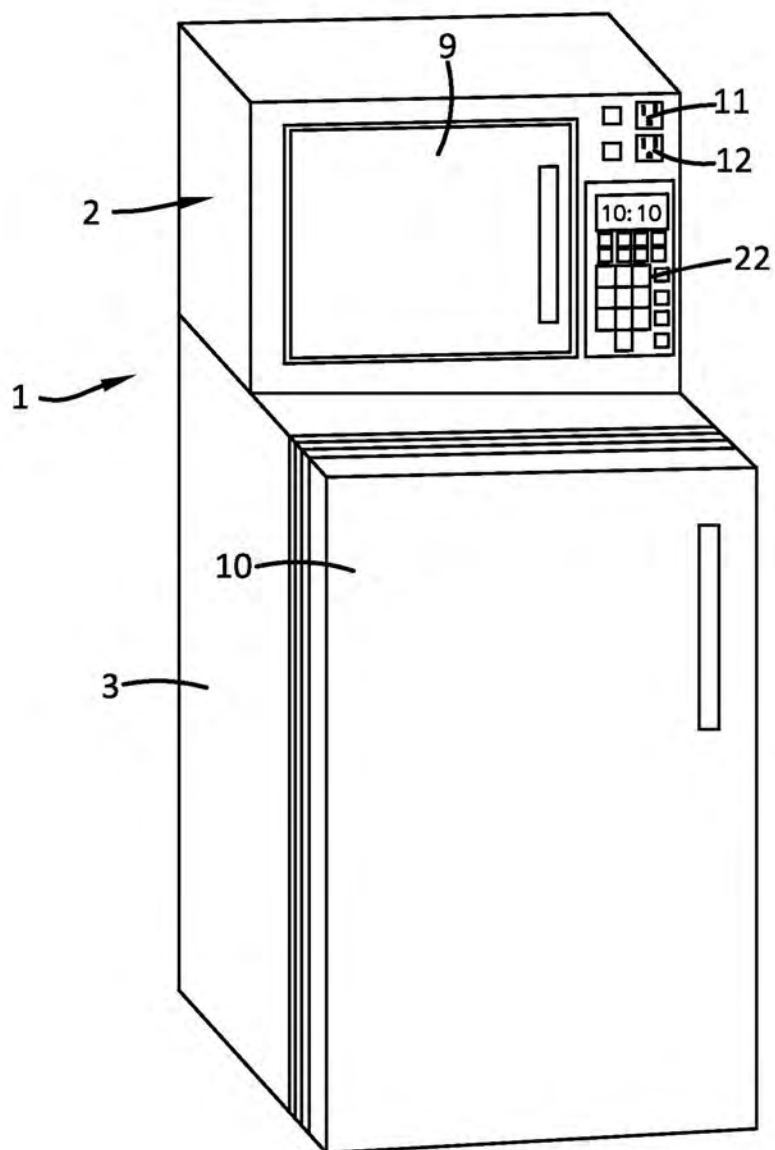


FIGURE 1

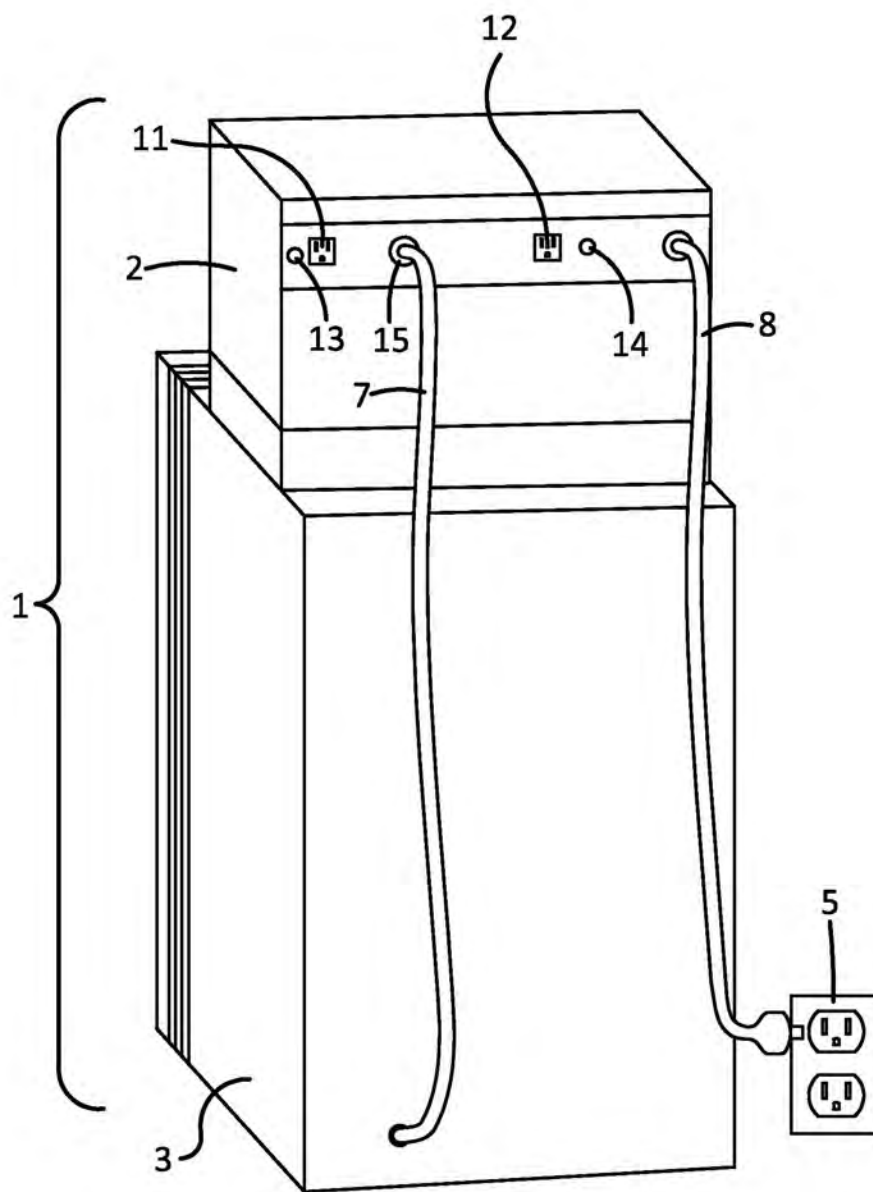


FIGURE 2

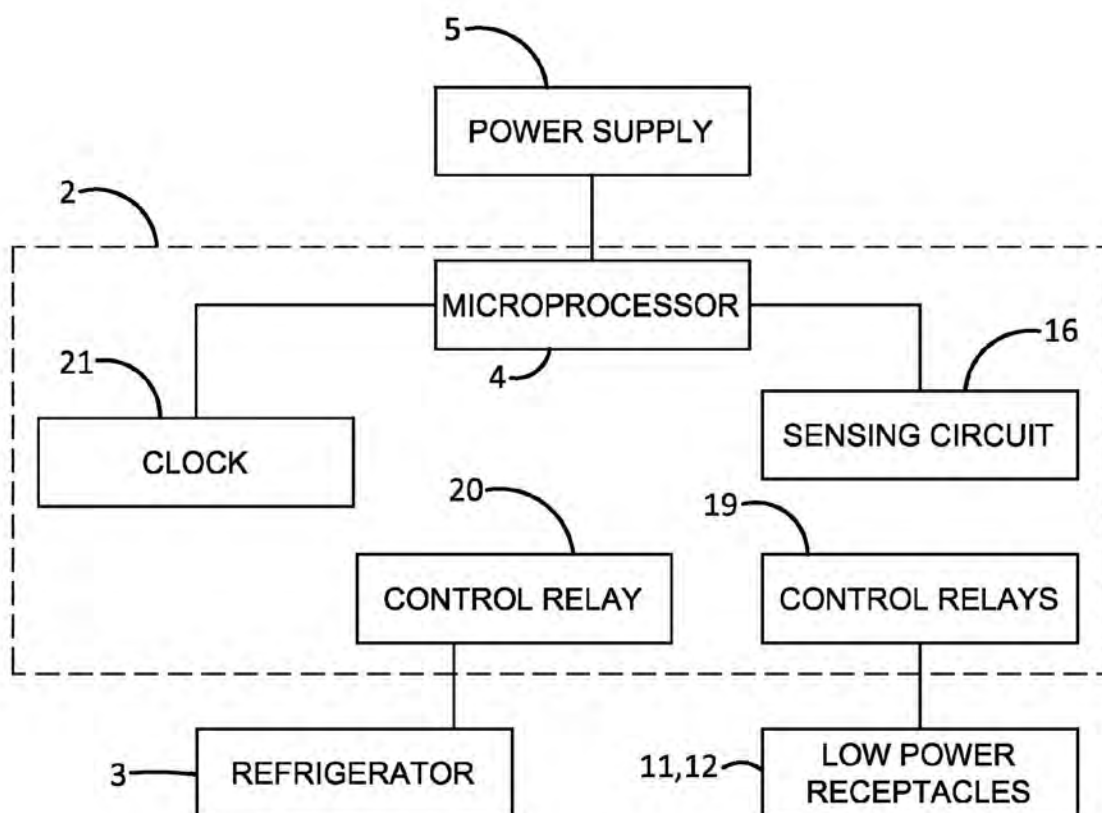


FIGURE 3

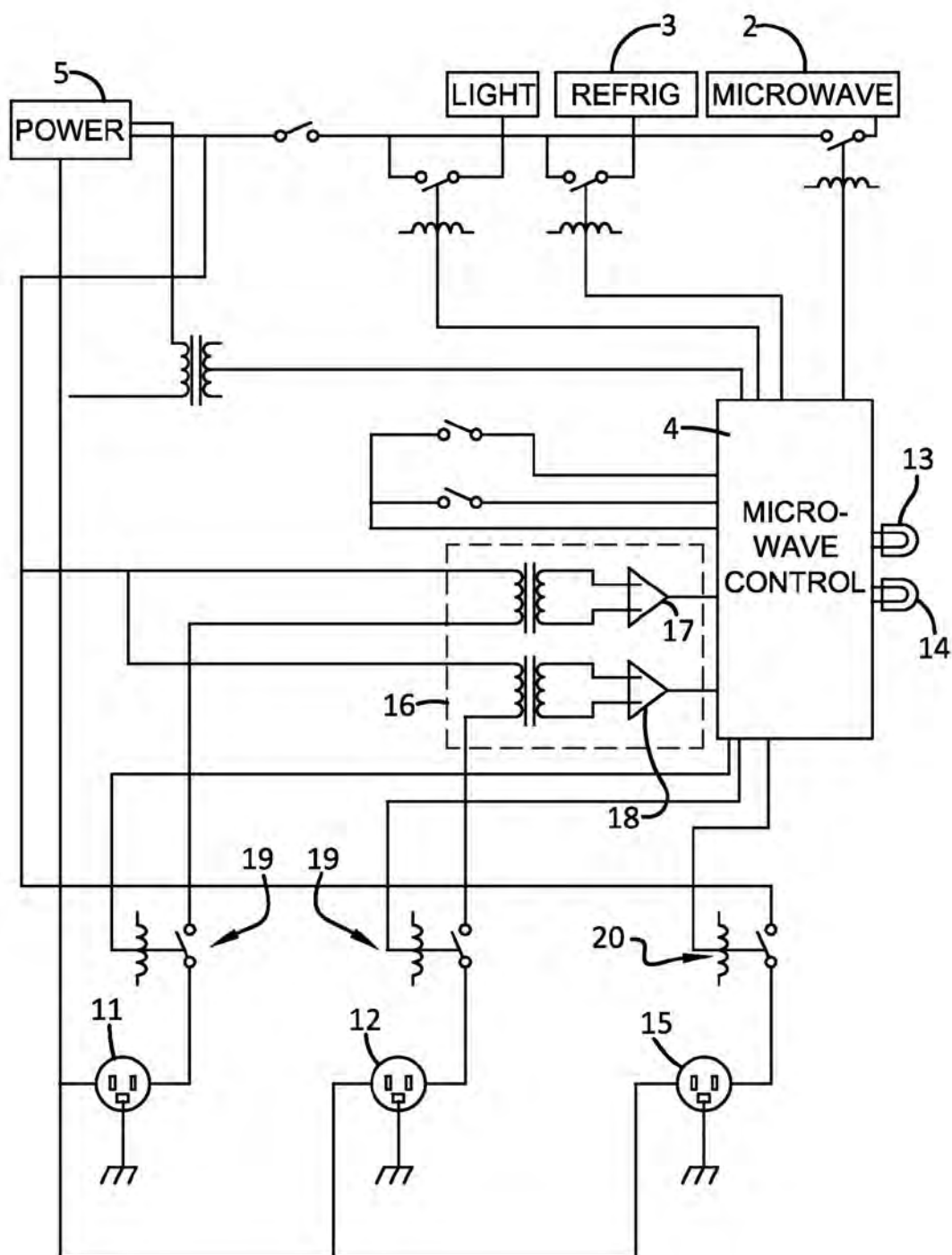


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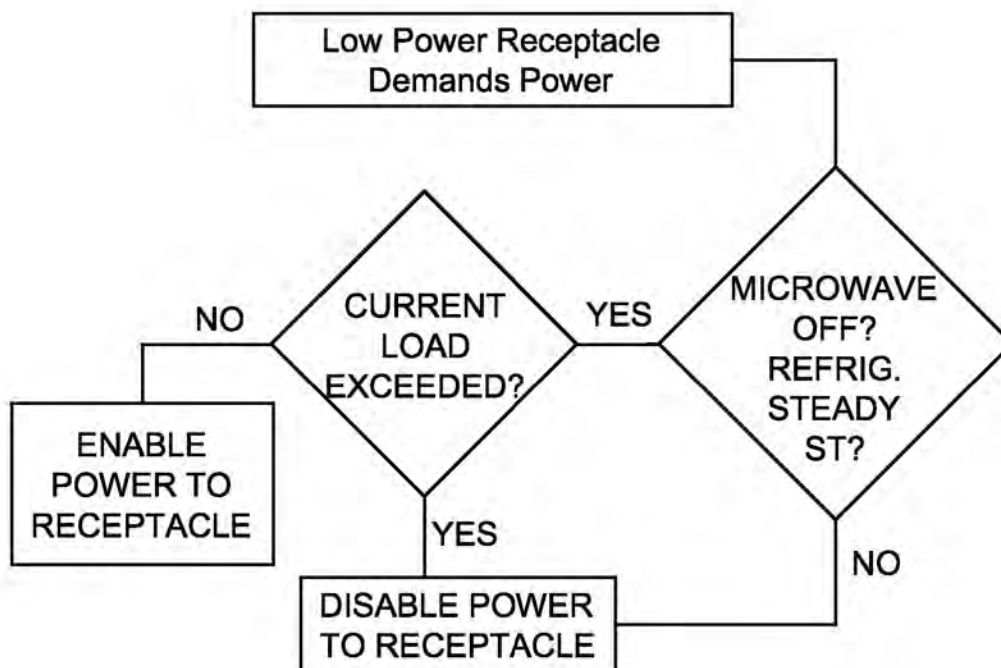


FIGURE 5

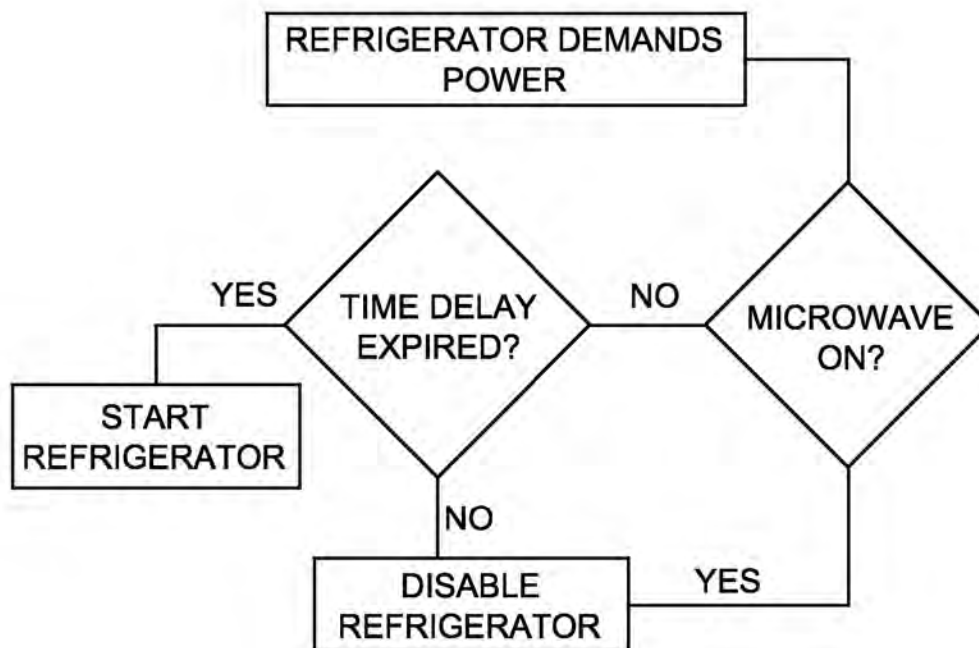


FIGURE 6

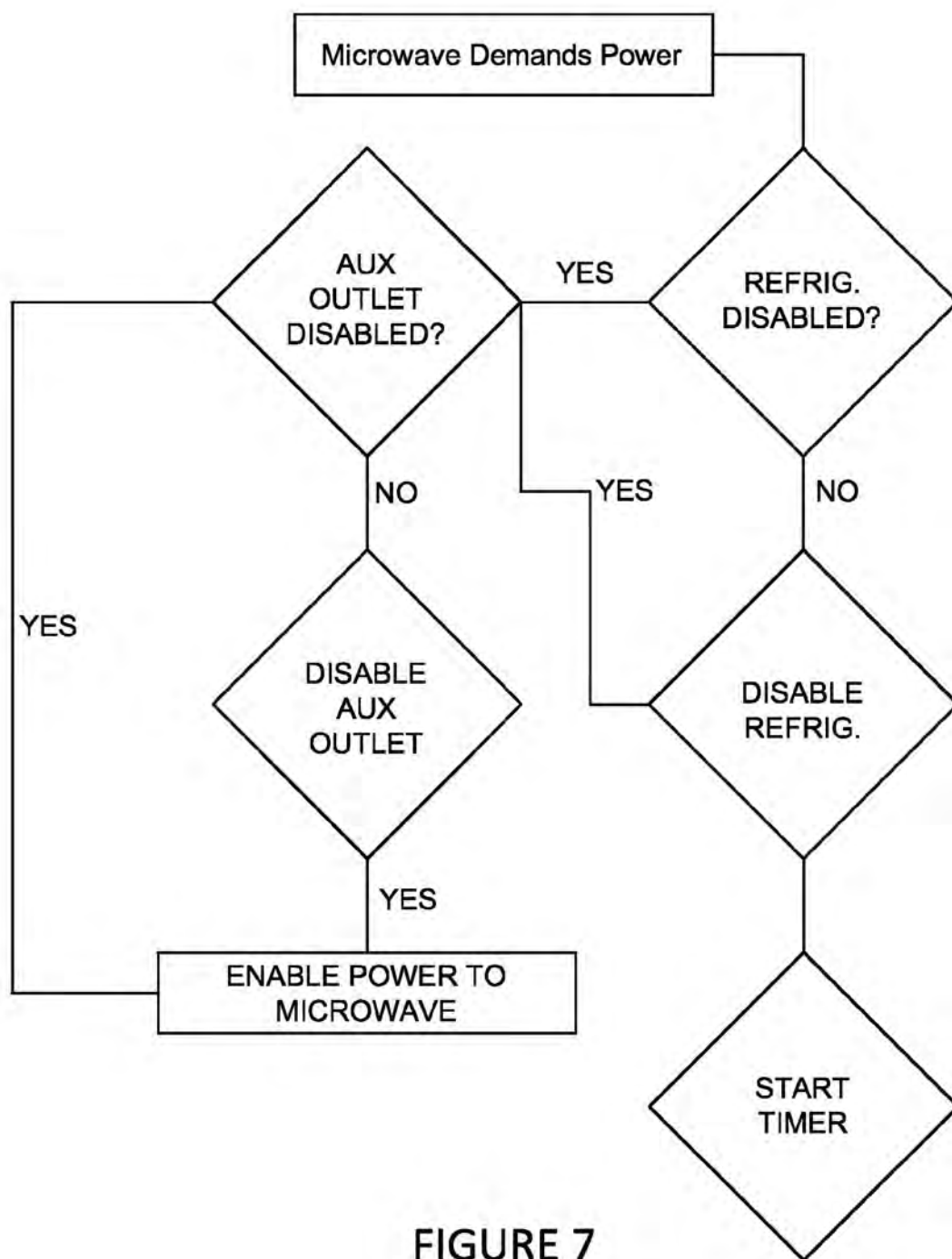


FIGURE 7

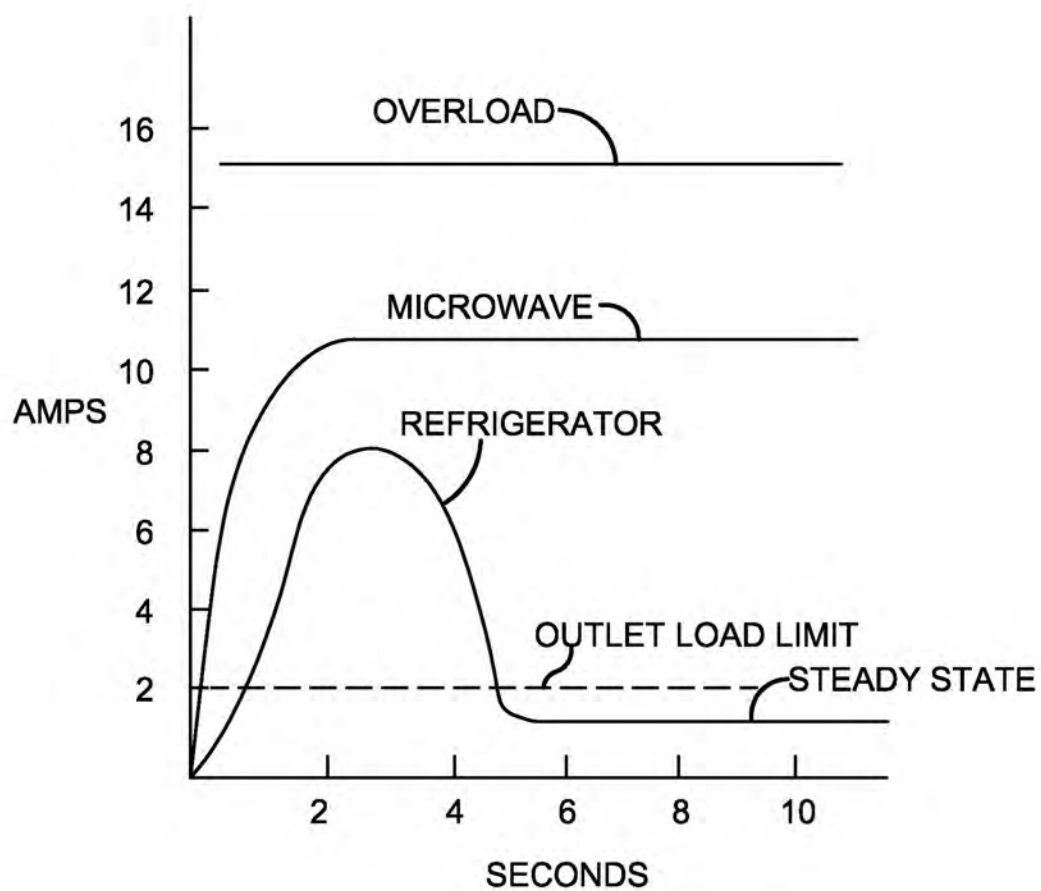


FIGURE 8

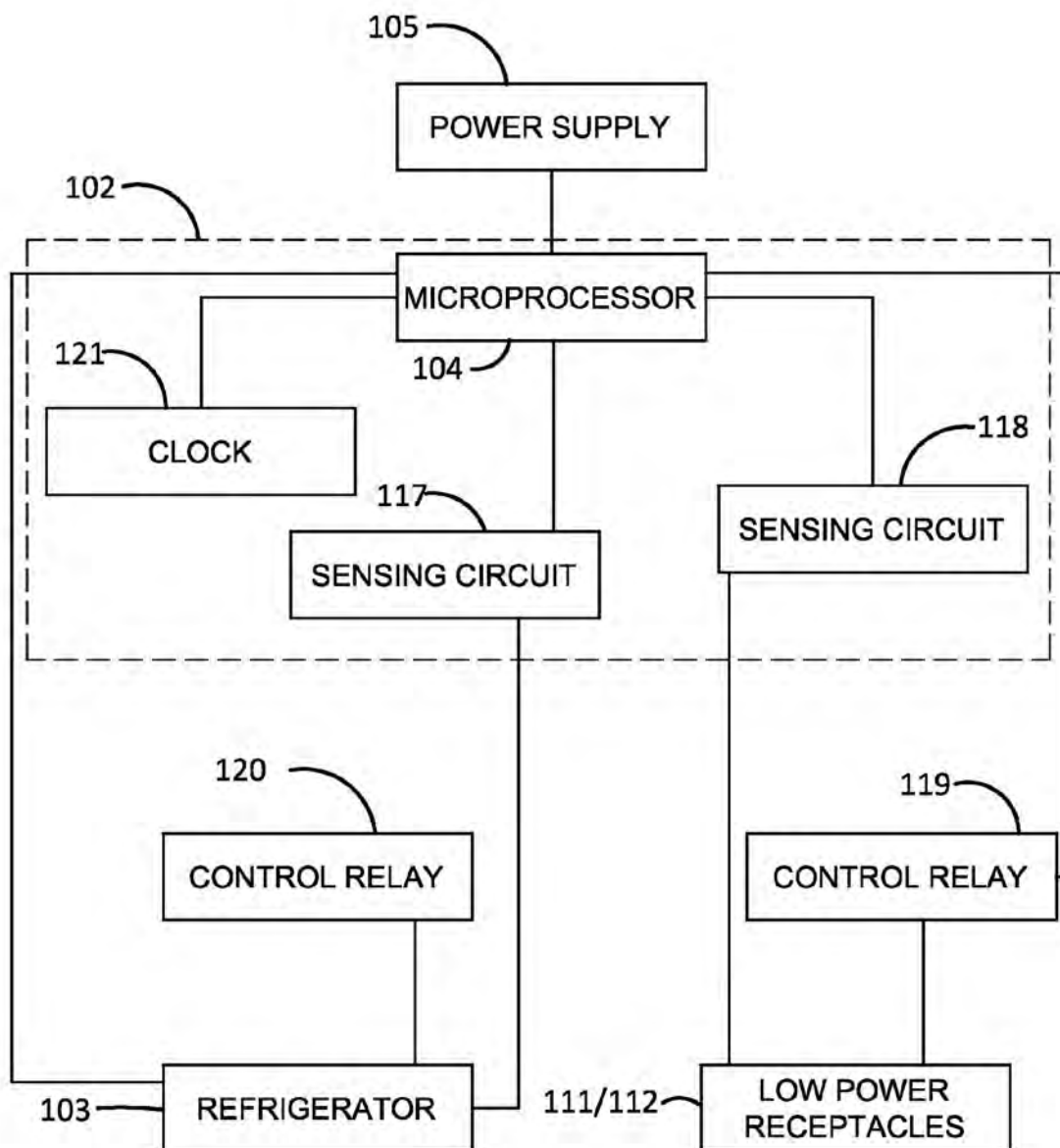
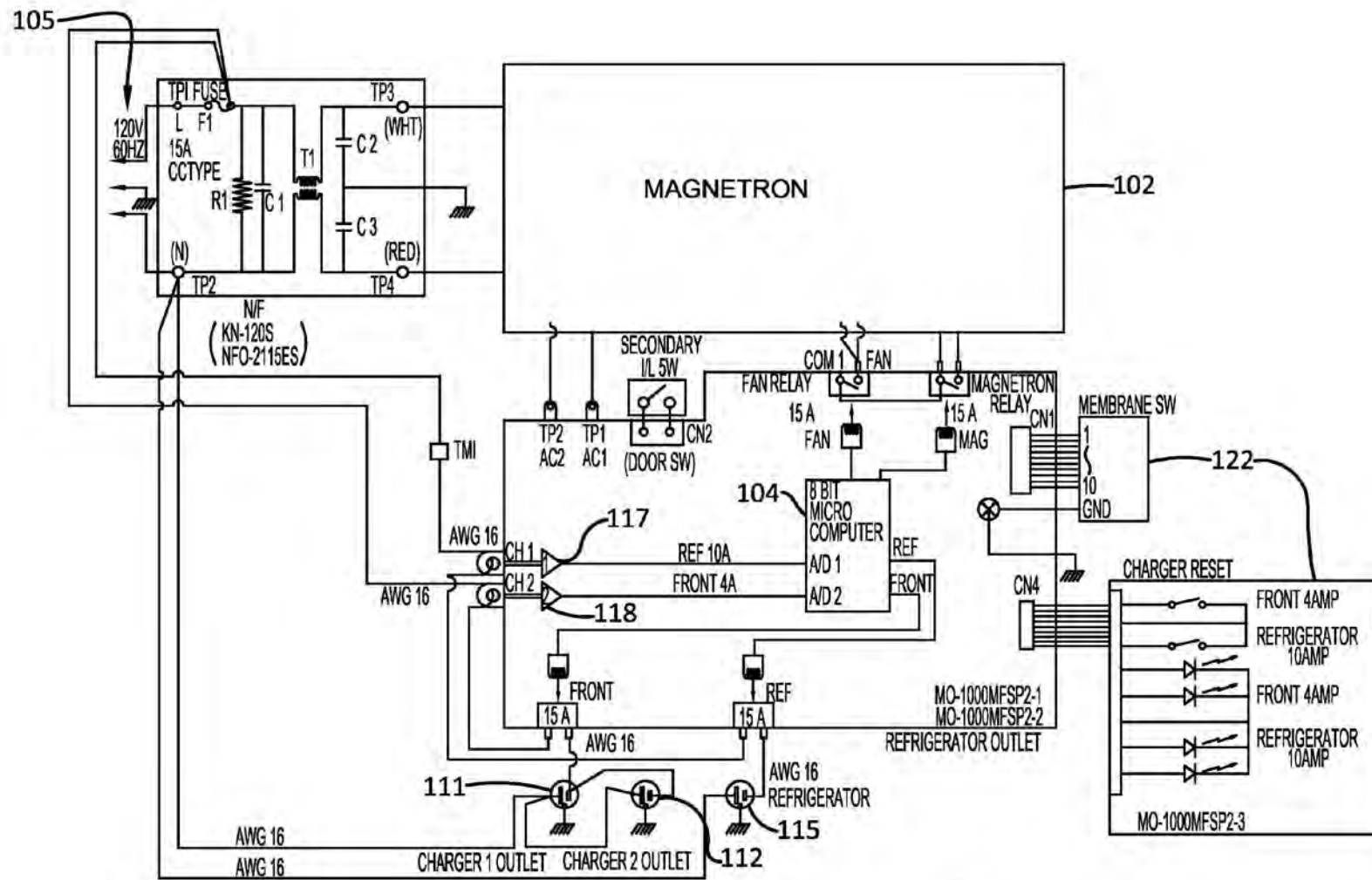
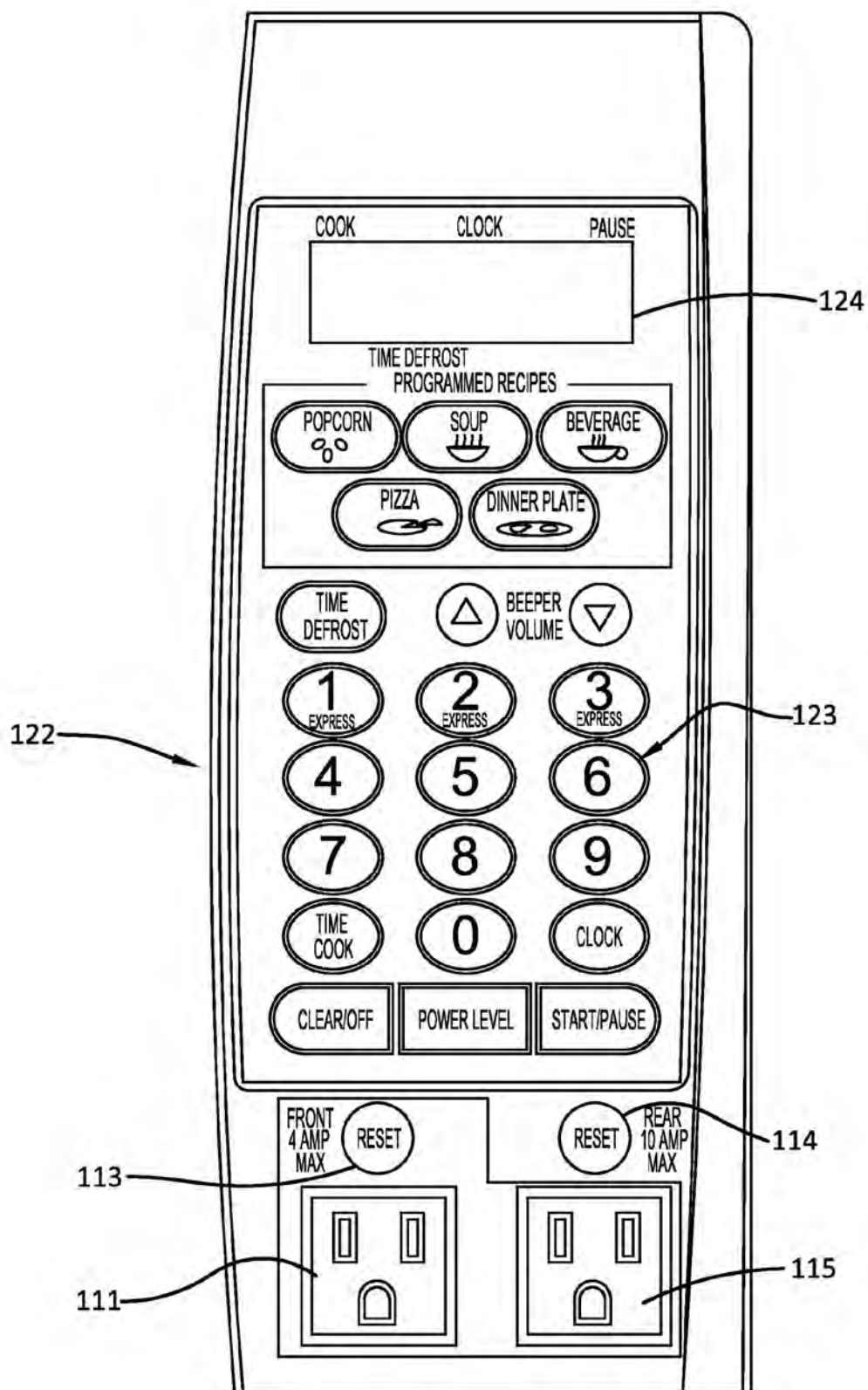


FIGURE 9





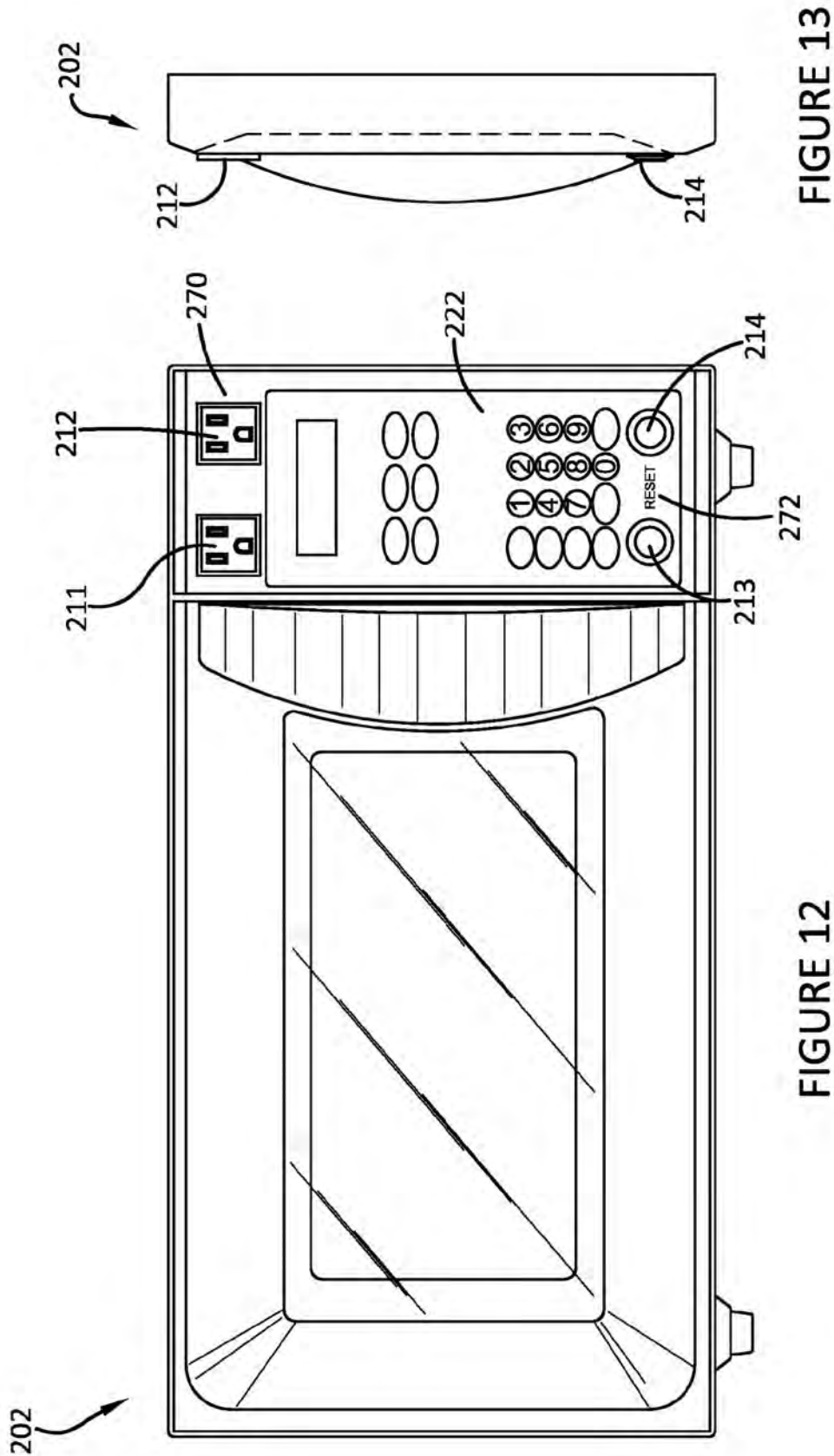


FIGURE 13

FIGURE 12

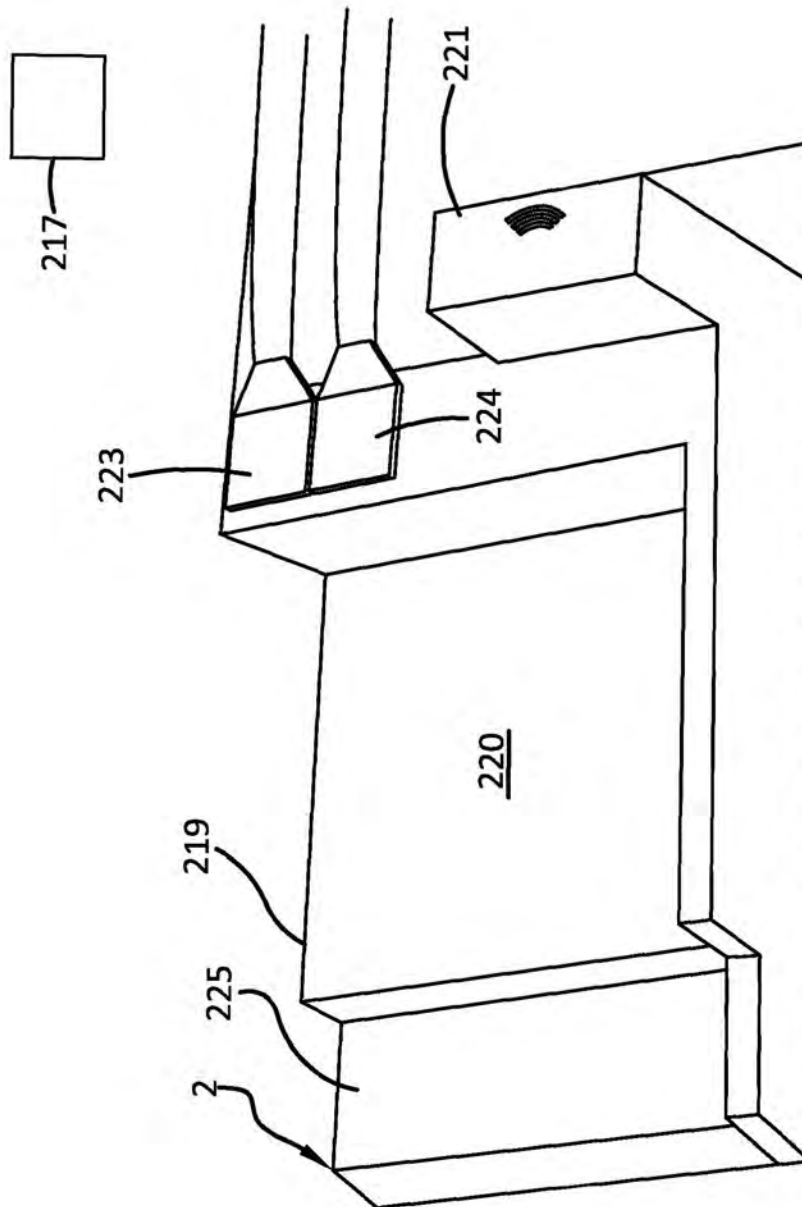


FIGURE 14

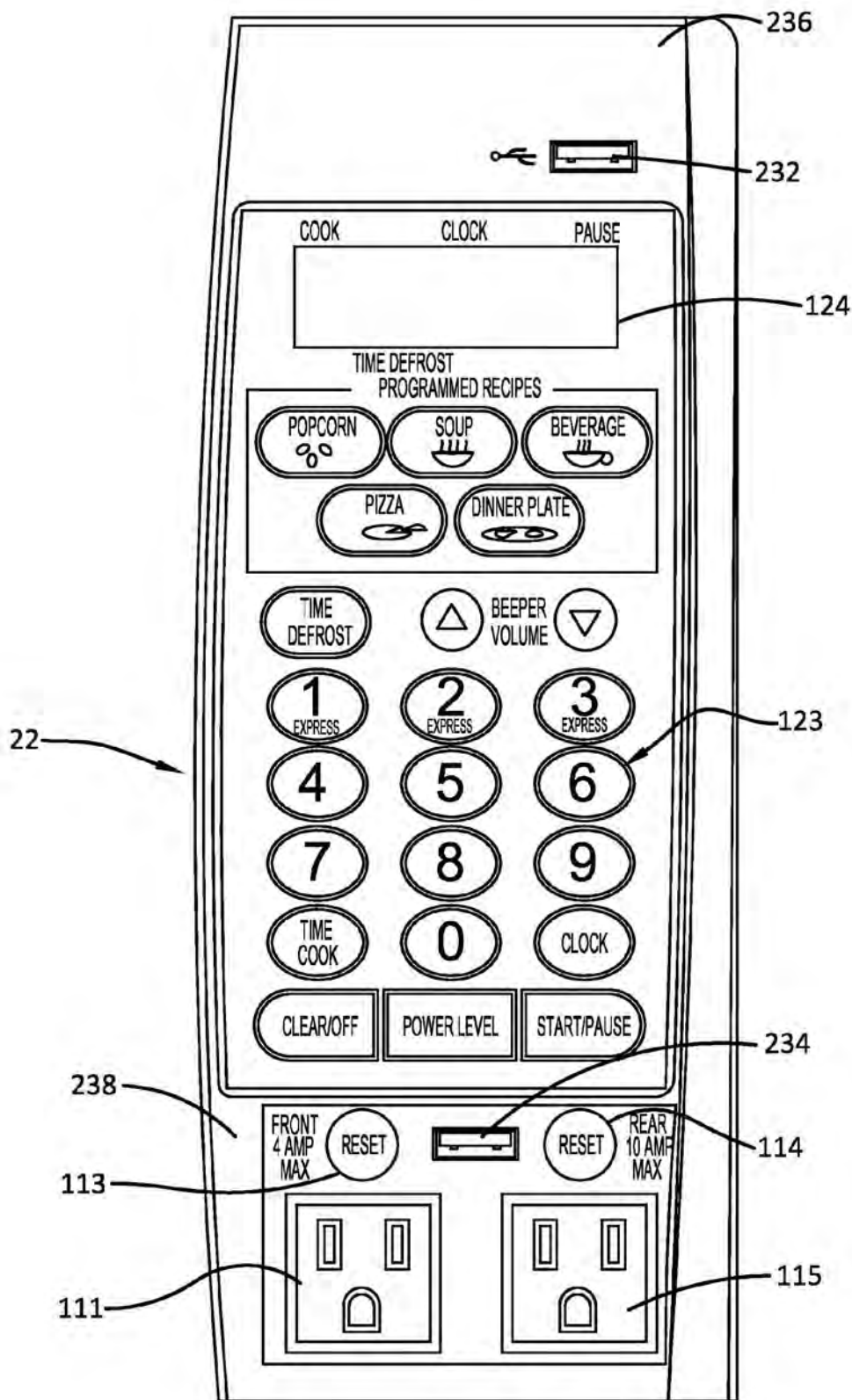


FIGURE 15

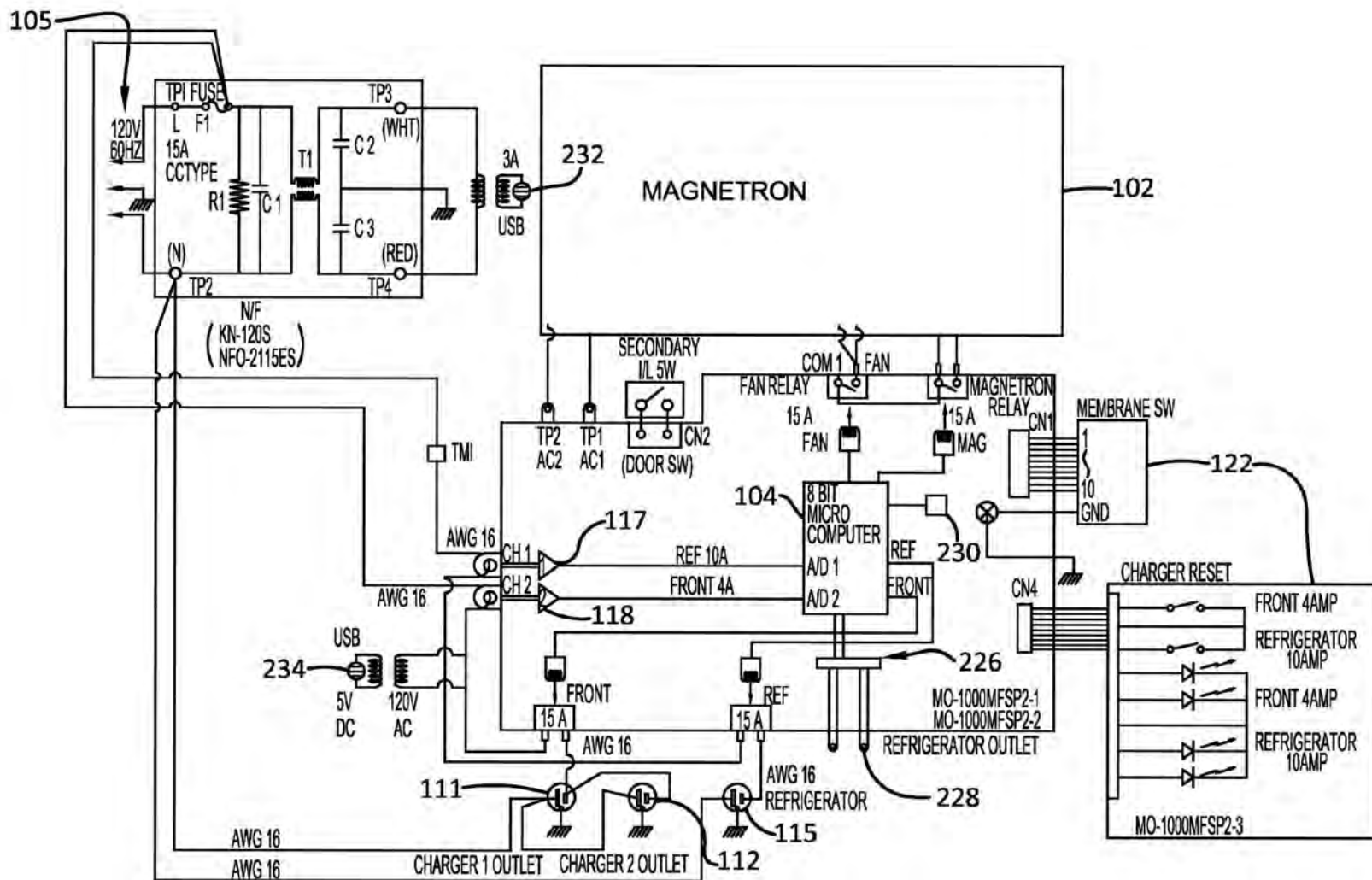


FIGURE 16

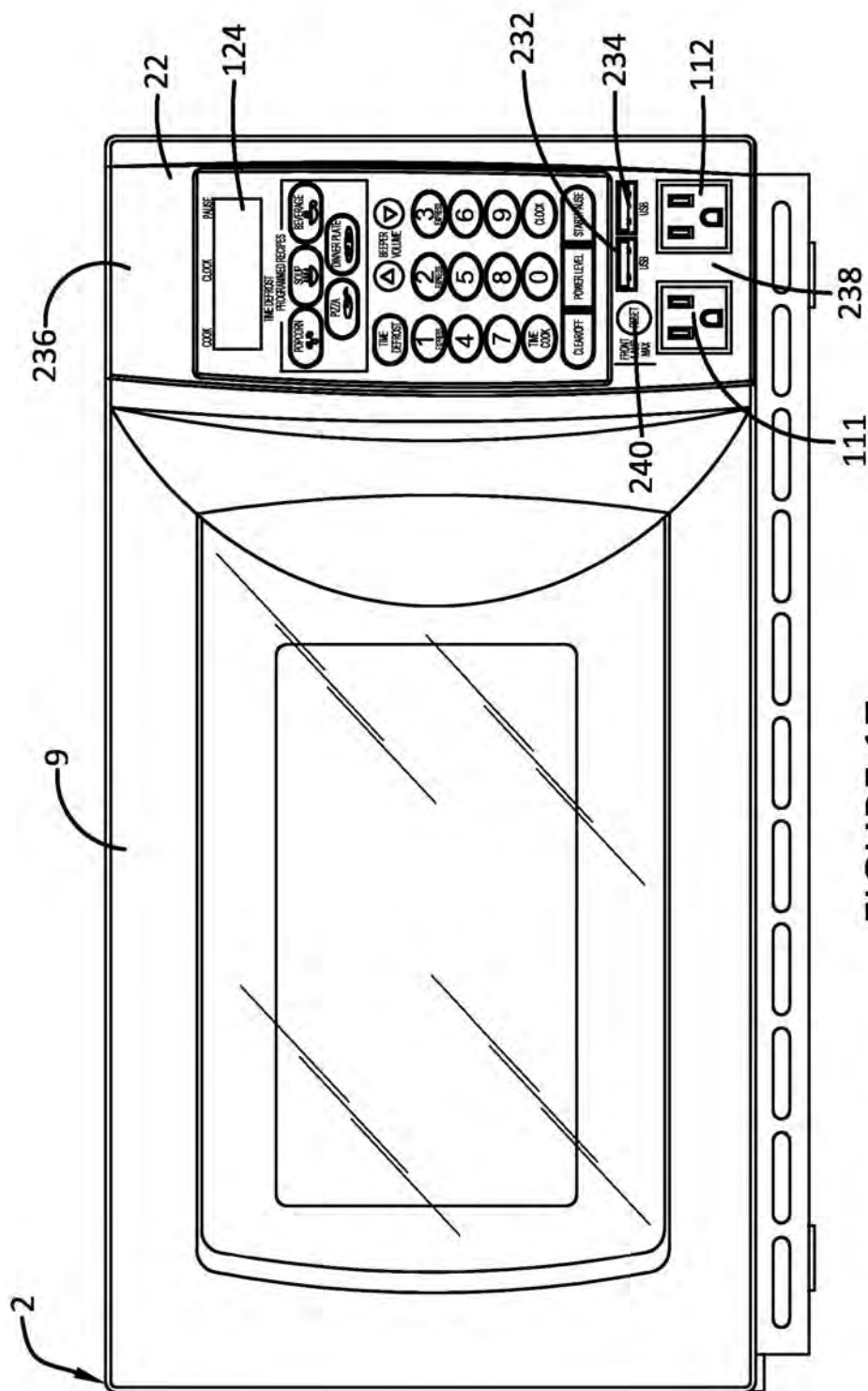


FIGURE 17

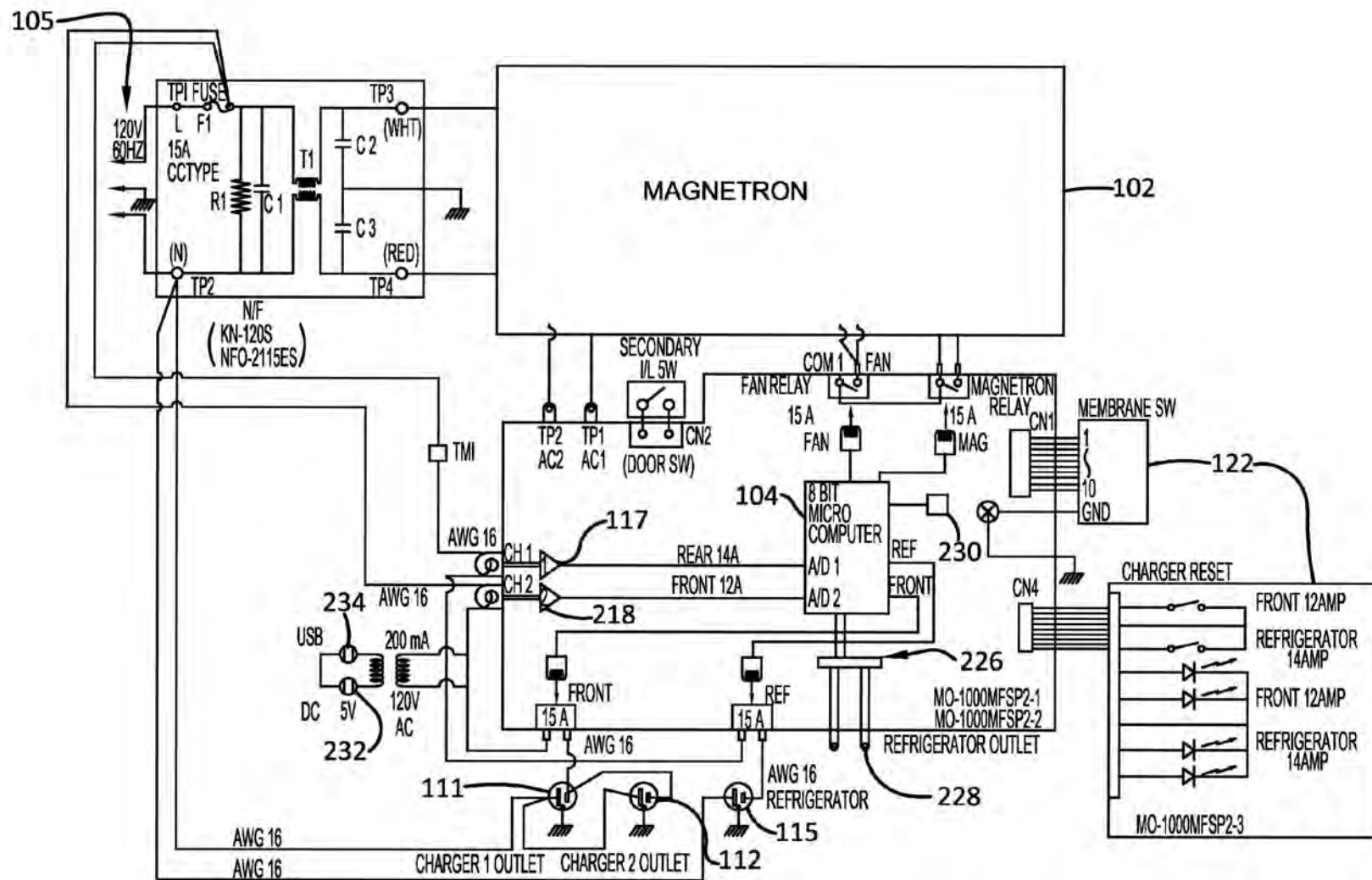


FIGURE 18

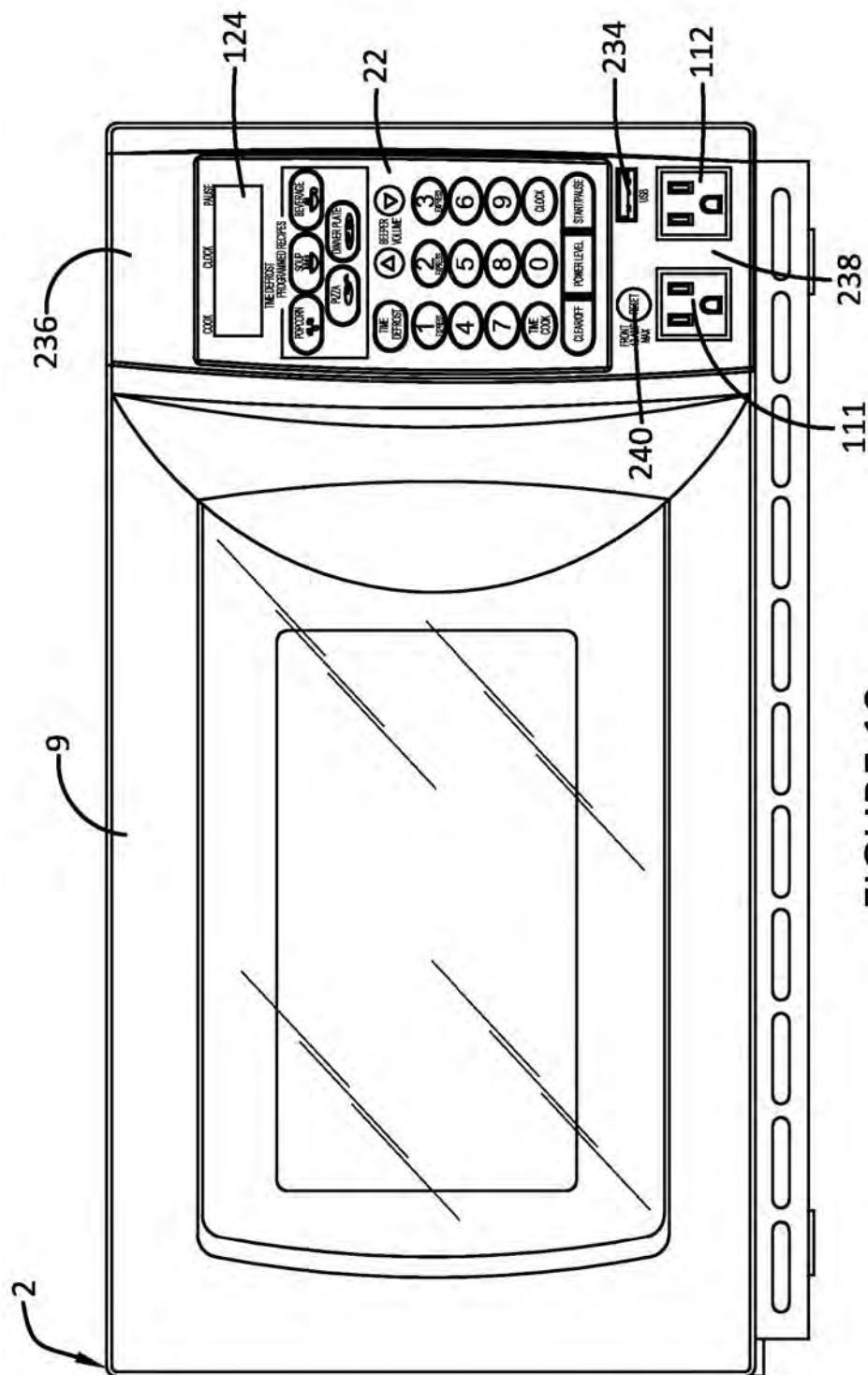
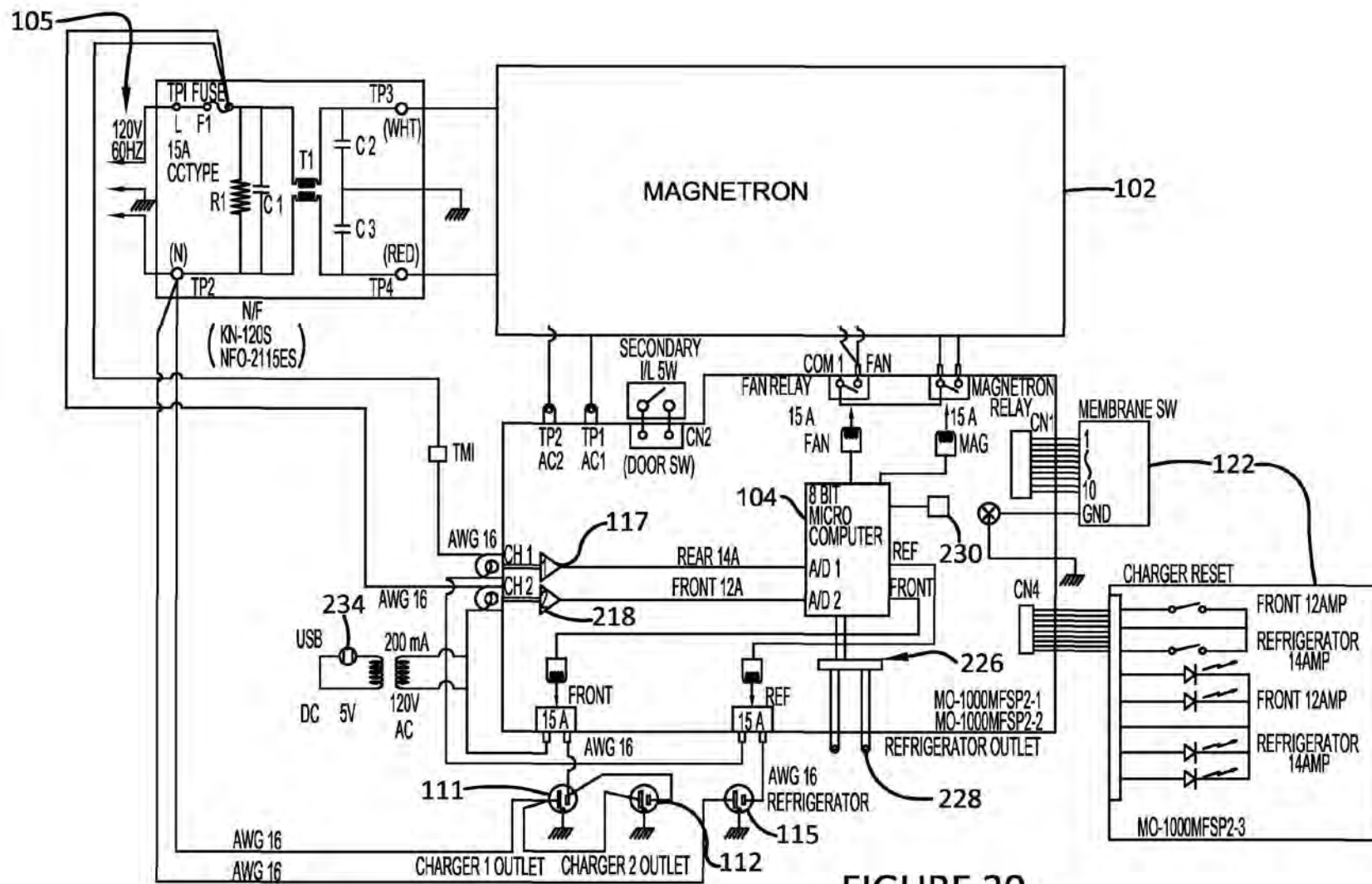
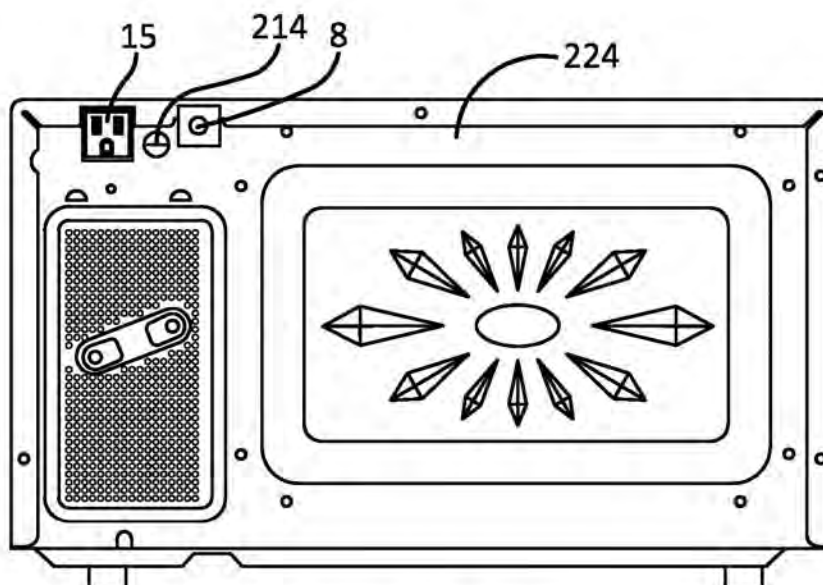
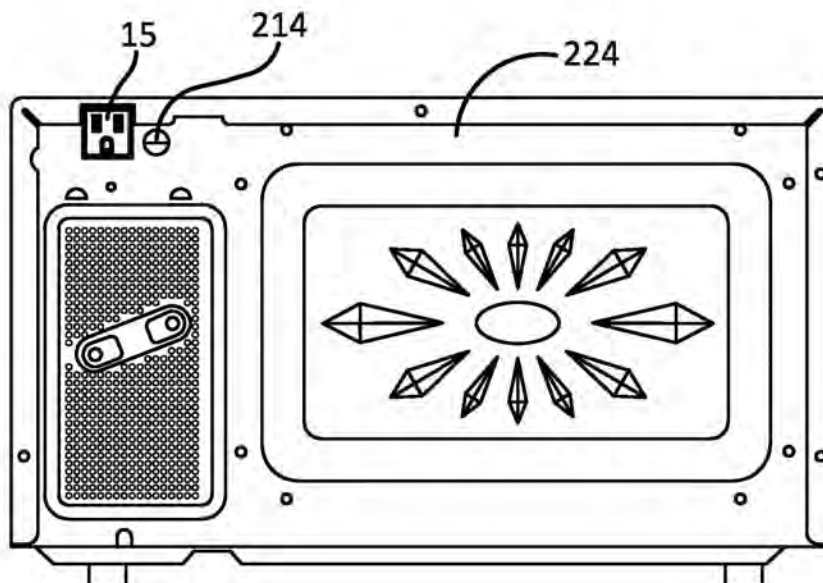


FIGURE 19





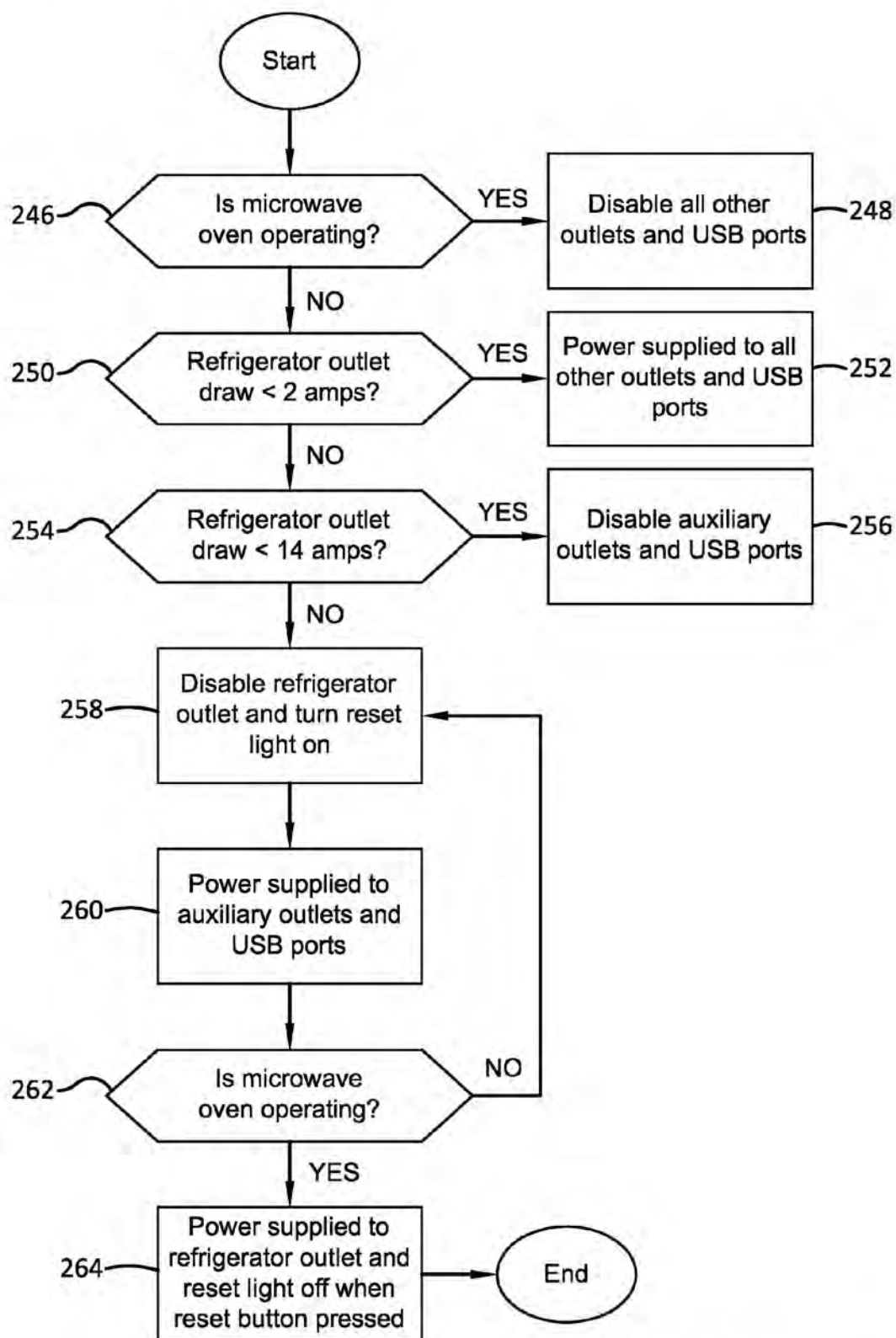


FIGURE 23

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MULTIPLE LINKED APPLIANCE WITH AUXILIARY OUTLET

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. application Ser. No. 12/317,632 filed on Dec. 23, 2008, which claims benefit under 35 U.S.C. § 119(e) of Provisional Application No. 61/009,419, filed Dec. 28, 2007, the disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

This application relates to a system of multiple linked appliances connected to a power supply through a single supply cord. In particular a refrigerator and microwave are connected for single plug operation while providing additional special purpose outlets.

BRIEF DESCRIPTION OF RELATED DEVELOPMENTS

Combination refrigerator and microwave oven systems are described in U.S. Pat. Nos. 4,880,954 and 4,847,722. In the devices described, the refrigerator is connected to the power supply and provides a connection for the microwave oven to be connected to the same supply. A single plug, therefore, serves to connect both appliances and the current required for each appliance is supplied by the same supply cord and circuit.

To make this combination attractive for use in dorm rooms, hotel rooms, recreational vehicles, tractor trailer cabs, and other similar locations, it is necessary to provide some means by which the peak currents of both appliances are not demanded from the supply at the same time. Many household circuits are protected from overload conditions by means of an automatic circuit breaker that is activated when current in the circuit exceeds the breaker rating. This is 15 amps in many circuits.

The duty cycle of a refrigerator used in these combined systems includes a current spike that occurs during the first few seconds of operation. This is the start up current for the refrigerator compressor and is considerably reduced, as the compressor obtains its operational speed. In typical refrigerator appliances the peak current may be in the range of 7 to 9 amps, while the steady state current may level off at 1.4 amps or less. A microwave oven demands a relatively steady 8 to 13 amps. It is apparent that an overload condition will occur frequently, when both appliances are in use, unless some control is exercised.

In the '954 patent the compressor power is disabled when the microwave is energized. This is accomplished by coupling the timer of the microwave to the compressor power. In addition a door interlock enables the compressor, since the microwave is disabled when the door is open. The '722 patent describes a control circuit for a combination microwave and refrigerator system in which a relay disables the microwave oven for a period of time depending on the rating of the compressor, when the compressor of the refrigerator is energized.

It would be advantageous to construct a combination microwave/refrigerator system that also provides auxiliary outlets for low power applications, such as for the purpose of recharging cellular phones, operating lap top computers

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and other low power devices, while controlling the operation of the appliances to avoid overload conditions.

SUMMARY OF THE INVENTION

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In an embodiment of this invention, a combination microwave and refrigerator system is constructed having a single plug input supply. The microwave oven is adapted to provide power to a refrigerator, and to auxiliary receptacles adapted for low power operation. The microwave oven includes a microprocessor controller adapted to monitor operation of the refrigerator compressor and controls the power to the microwave magnetron and other components. The current to the low power receptacles are separately monitored for control by the microwave controller. The microwave controller is adapted to balance the duty cycles of the connected appliances attached to avoid overload conditions. A control algorithm is implemented internally within the microwave controller. A receptacle for the refrigerator and the low power auxiliary receptacle may be implemented as part of the microwave control panel.

In one embodiment, the auxiliary outlets are constructed to provide low power for the purpose of recharging cellular phones, personal media devices, digital cameras, in addition to operating lap top computers and other low power devices. The current to the auxiliary outlets is sensed and provided to the microwave controller.

In another embodiment, the power to the auxiliary outlets is disabled by the microwave controller when the microwave magnetron is energized or whenever the current to the auxiliary outlets exceeds a preset value.

In one embodiment, a control model is established and executed by the microwave controller. The model is dependent on the state of operation of the microwave magnetron. As part of the control model, the power to the compressor is monitored to sense operation of the compressor. When power to the microwave is demanded, the compressor is disabled for a preset minimum period. When microwave demand ceases, refrigerator power is restored provided, that the preset minimum period has expired.

In another embodiment of the control module, sensing circuits are connected to monitor current to the auxiliary outlets. The control model is adapted to disable the power to the auxiliary receptacles, if the microwave is in operation. In addition the auxiliary receptacles are disabled if a predetermined maximum current is sensed. Another control model is based on operation of the refrigerator and operates to disable the auxiliary receptacles when the compressor is in the start-up mode.

In one aspect of the invention, a non-transitory processor storage readable medium having processor readable program code embodied therein for operating a control processor to control a system of multiple linked appliances having a microwave oven, a refrigerator, and an auxiliary power supply outlet is provided. The processor readable program code causes the control processor to disable the refrigerator and the auxiliary power supply outlet, when the microwave demands power, and enable the auxiliary power supply outlet when the microwave is off.

BRIEF DESCRIPTION OF THE DRAWINGS

The system of this invention is explained in more detail below with reference to the accompanying drawing, in which:

FIG. 1 is a front perspective view of an embodiment of an appliance system of this application.

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FIG. 2 is a rear perspective view of the embodiment of FIG. 1 showing an alternative arrangement;

FIG. 3 is a block diagram of an embodiment of the system of this application;

FIG. 4 is a schematic diagram of the embodiment of FIG. 3;

FIG. 5 is a flow diagram of an embodiment of this application;

FIG. 6 is a flow diagram of another embodiment of this application;

FIG. 7 is a flow diagram of another embodiment of this application;

FIG. 8 is a graph illustrating the duty cycles of the appliances in the system of FIG. 3;

FIG. 9 is a block diagram of an alternate embodiment of this application;

FIG. 10 is a schematic diagram of the embodiment of FIG. 9; and

FIG. 11 is an illustration of a control panel of the embodiment of FIG. 9.

FIG. 12 is a front view of the microwave oven according to another embodiment of this application.

FIG. 13 is a side view of the microwave oven of FIG. 12

FIG. 14 is a top perspective view of a charging pad on the top portion of the microwave oven of this application.

FIG. 15 is an illustration of a control panel of an alternate embodiment of this application.

FIG. 16 is a schematic diagram of the embodiment of FIG. 15.

FIG. 17 is a front view of the microwave oven according to another embodiment of this application.

FIG. 18 is a schematic diagram of the embodiment of FIG. 17.

FIG. 19 is a front view of the microwave oven according to another embodiment of this application.

FIG. 20 is a schematic diagram of the embodiment of FIG. 19.

FIG. 21 is a rear view of the microwave oven according to the embodiments of FIGS. 12-19.

FIG. 22 is a similar view as that of FIG. 21 except that the AC cord is shown.

FIG. 23 is a flow diagram of an embodiment of this application.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A multiple linked appliance system 1, for example, a combination microwave oven 2, a refrigerator 3 incorporating features of the present invention is illustrated in the figures. Although the present invention will be described with reference to the embodiments shown in the drawings, it should be understood that the present invention may have many alternate forms. In addition, any suitable size, shape or type of elements or materials could be used. The computer operated devices described in this application may be constructed having one or several processors and one or several program product modules stored in one or several memory elements. For illustration, computer components may be described as individual units by function. It should be understood, that in some instances, these functional components may be combined.

One embodiment of a multi-appliance interconnected system 1 is illustrated in FIG. 1. This embodiment consists of two stand alone appliances, a refrigerator 3 and a microwave oven 2. Refrigerator 3 is connected to microwave oven 2 by power cord 7 to refrigerator receptacle 15, shown at the

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rear of the microwave 2 in FIG. 2. Refrigerator 3 is generally subject to control by the microwave microprocessor controller 4 of the microwave oven 2. A single cord 8 provides input power to the system 1 from receptacle 5 through microwave 2. In the case where stand alone appliances are used, as shown in FIGS. 1 and 2, microwave oven 2 is connected directly to power source 5. The refrigerator 3, as the heaviest component, is used as the base with the microwave oven 2 stacked on top. In the selection of the refrigerator 3, it would be advantageous in one embodiment for the height of the refrigerator to be no more than 48 inches above the floor. This provides a more ergonomic operation of the microwave oven 2 for the user. In addition, in the stacked position of the appliances in an embodiment, the doors 9 and 10 of the microwave 2 and refrigerator 3, respectively, should be arranged in a common plane. The appliances may be of standard design with features commonly available. The internal components of the appliances are well known and do not need to be described herein.

Microprocessor 4 is the controller for the operation of the microwave oven 2 and is also adapted to control the other components of system 1, as shown in FIG. 3. Power is distributed throughout the system 1 under control of microwave controller 4 and digitally operated switches such as relays 19 and 20 of FIG. 3. Power is distributed to each of the appliances 2 and 3, and to auxiliary low power receptacles 11 and 12. In use lamps 13 and 14 in the form of LED's or the like may be connected to the auxiliary receptacles to indicate power being available or disabled. The low power auxiliary receptacles 11 and 12 are provided to permit convenient access for plugging in a low power device for example, rechargeable devices, such as cellular phones, PDA's, or other electronic devices that do not demand high power. As shown in the graph of FIG. 8, there are instances during which, if more than one of the appliances is in use, the cumulative current would cause an overload condition.

Control panel 22 of microwave oven 2 may be adapted to provide a display of the particular status of the controlling relays, for example, LED's 13 and 14 may indicate that power to the outlets 11, and 12 are disabled or available. In one embodiment the lamps will light when power is available at the outlet and flash when disabled. In another embodiment the lamps will light when power is disabled at the outlet and not activate when power is available at the outlet as a means to reduce the Standby Power requirements. A button operated touch panel provides manual control.

As shown in FIG. 4, in order to control the power to the microwave 2, refrigerator 3 and receptacles 11 and 12, sensing circuits, may be coupled to the controller to monitor current to the appliances and the auxiliary receptacles. A relay 20 is connected in the power line to the refrigerator and may be actuated by signals from controller 4. In particular, according to an embodiment of this application, sensing circuits 16, as shown in FIG. 4, have sensors 17 and 18 coupled to the power line of the auxiliary outlets 11 and 12 to monitor the current being used by a connected device. Sensors 17 and 18 may be current sensing transformers of the type available from Triad Magnetics of Corona, Calif. The signals generated by sensors 17 and 18 may be used to activate switches or other control components, such as relays 19. Relays 19 may be actuated by controller 4 to enable and disable power to the low power auxiliary outlets 11 and 12 in response to signals from sensors 17 and 18. A maximum current may be set by controller 4 to prevent

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overload of the outlets 11 and 12. In one embodiment of the system of this application, the maximum current limit is set at 2 amps.

In another embodiment, a clock device 21 could be used to provide timed delays during which, for example, refrigerator 3 would be prevented from undesirably rapid on/off cycles. When refrigerator 3 is disabled during microwave operation, a time delay of 3 minutes is provided during which refrigerator 3 will remain disabled, even if microwave use is only for a short period. Controller 4 may be programmed to manage the power to the components of the system to avoid overload conditions, while minimizing disruptions in the use of an individual appliance. A model of operative events and related control operations may be designed into the program executed by controller 4 to provide a control methodology as illustrated in FIGS. 5-7.

In one embodiment, as illustrated in the block diagram of FIG. 3, microprocessor controller 4, constructed as part of the controller for microwave 2, would be adapted to process the sensor signals and identify particular events in the system 1 related to a particular appliance. Microprocessor 4 would control the power to microwave 2 and refrigerator 3 and also low power receptacles 11 and 12 to avoid overload conditions. The microprocessor 4 could be programmed to execute the control methods illustrated and described below. In a preferred embodiment, the controller 4 is the control microprocessor for microwave oven 2 and is adapted to execute the control algorithms described below. Controller 4 is coupled directly to refrigerator outlet 15 and low power outlets 11 and 12.

In one embodiment, shown in FIG. 1, the outlets 11, and 12, are installed as part of the front control panel of microwave oven 2. In FIG. 2, in another embodiment, the auxiliary receptacles 11 and 12 and refrigerator receptacle 15 are accessible at the rear of the microwave oven 2. In these alternative embodiments, the microwave oven 2 is connected by supply cord 8 directly to power supply receptacle 5. Refrigerator 3 is connected by power cord 7 to receptacle 15 in microwave oven 2 as shown in FIG. 2.

In one embodiment, control models are established as shown in FIGS. 5-7 for execution by the controller 4. These models can be in the form of algorithms stored in a computer readable medium, such as software or firmware within microprocessor 4. The models shown are, in the first instance, dependent on the state of operation of microwave oven 2. The current demands of the microwave 2 are generally the most significant contribution to overload, as shown in FIG. 8. To avoid overload conditions, power to the low power receptacles 11 and 12 and refrigerator receptacle 15 is disabled during microwave operation. If the refrigerator 3 is under power when the microwave 2 is turned on, the power, to the refrigerator is turned off and clock 21 begins to count for a predetermined period during which the compressor of refrigerator 3 cannot be restarted. A time delay, for example, of 3 minutes, may be set and when this delay period is expired, receptacle 15 may again be enabled, providing microwave operation has ceased. This prevents a too rapid restart of the compressor that may otherwise result in damage.

In the embodiment shown in FIG. 5, if low power is demanded at receptacle 11 or 12 and microwave oven 2 is not in use, power is supplied to the low power receptacles, providing further, that the current demand in an individual outlet does not exceed a preset limit, for example, 2 amps. Since the auxiliary outlets may be enabled during refrigerator operation, there may be an overload generated at peak compressor operation. In one embodiment the microwave

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controller acts to disable the auxiliary outlets during compressor startup to prevent accidental overload of the system. Therefore as illustrated in the flow diagram of FIG. 5, controller may be adapted to check the operational status of the refrigerator, as well as the microwave oven, prior to enabling the auxiliary outlets.

FIGS. 9-11 illustrate another embodiment. In this embodiment the sensing components 117 and 118 are connected to reduce the risk of overload by the combined demands of the auxiliary outlets 111 and 112 and the refrigerator outlet 115. In the configuration, as shown in FIG. 10, current sensor 117 is connected to monitor the current in the refrigerator outlet 115 and is constructed to limit the refrigerator current component so that it does not exceed 10 amps. Current sensor 118 is connected to monitor the combined current in the auxiliary outlets 111 and 112. Current sensor 118 is constructed to limit the combined auxiliary outlet current to 4 amps. In this manner the risk of overload is minimized. In the block diagram of FIG. 9, the microwave 102 having controller 104 is connected to power supply 105. Clock 121 provides a timing device to generate a restart delay for refrigerator 103. Sensing circuit/sensor 117 is connected to monitor the current demanded by refrigerator 103 and sensing circuit/sensor 118 is connected to low power receptacles 111 and 112 to monitor the combined current in receptacle 111 and 112.

In this embodiment, as shown in FIG. 11, a control panel 122 is arranged with a keypad 123 for manual control and a display 124. Auxiliary outlet 111 is shown as accessible from the front and is associated with a status LED indicator and reset button 113 that may be caused to be on during use and switch to a flashing mode when the microwave is running. Refrigerator outlet 115 is also shown to be accessible from the front panel and is associated with an LED indicator and reset button 114. Similarly LED indicator 114 is controlled to be on during use of the refrigerator and to switch to a flashing mode when the microwave is operating. In another embodiment, the status LED indicator and reset button 113 may be caused to be off during use and switched on or to a flashing mode when the microwave is running. Similarly, in this another embodiment, the LED indicator 114 is controlled to be off during use of the refrigerator and switched on or to a flashing mode when the microwave is operating.

A further embodiment of the processor operational model is shown in FIG. 6. In this model, the refrigerator demands power. This may be triggered by a temperature drop in the refrigerator and involve start up of the refrigerator compressor with an associated peak power demand. If the microwave is on, the recycling of the refrigerator will be delayed. If the microwave was on and subsequently cycled off, the clock 21 must be checked to determine if the restart can occur. Under some circumstances, it may be necessary to give the refrigerator priority to prevent an undesirable drop in temperature. In the latter instance, microcontroller can be coupled to the refrigerator temperature sensor to execute a time sequence during which the microwave will be disabled to allow the refrigerator to return to proper operating temperatures.

In the embodiment of FIG. 7, priority is given to the power demands of the microwave oven, as indicated above. Use of the receptacles 11, 12, and 15 are, therefore, disabled during microwave operation. The operational models, illustrated in FIGS. 5-7, may be established by algorithms that are programmed or imbedded in controller 4.

In this manner a system of linked appliances, including a microwave oven, refrigerator, and a low power appliance

may all be connected through a common supply cord without the risk of inconvenient interruptions in use caused by overloads.

In another exemplary embodiment as illustrated in FIGS. 12 and 13, the auxiliary outlets or receptacles 211, 212 may be installed as part of the front control panel 222 of the microwave oven 202 and located on the upper portion 270 of the front control panel 222. The auxiliary outlets 211, 212, front control panel 222 and microwave oven 202 are similar to auxiliary outlets 11, 12, front control panel 22, and microwave oven 2 except for that discussed below. In this exemplary embodiment, the auxiliary outlets 211, 212 are positioned side by side with respect to each other with each of the auxiliary outlets 211, 212 being at the same height as the other. The auxiliary outlet 211 of FIG. 12 may be associated with a status LED indicator and reset button 213, which is located on the lower portion 272 of the front control panel and in vertical alignment with the auxiliary outlet 211. The status LED indicator and reset button 213 may be caused to be on during use and switched to a flashing mode when the microwave oven 202 is running. The auxiliary outlet 212 of FIG. 12 may be associated with status LED and reset button 214, which is located on the lower portion of the front control panel and in vertical alignment with the auxiliary outlet 212. The status LED indicator and reset button 214 may be caused to be on during use and switched to a flashing mode when the microwave oven 202 is running. In another embodiment, the status LED indicator and reset button 213 may be caused to be off during use and switched on or to a flashing mode when the microwave oven is running. Similarly, in this another embodiment, the status LED indicator and reset button 214 may be caused to be off during use and switched on or to a flashing mode when the microwave oven is running. All other elements are similar in structure and function as that of the embodiments shown in FIGS. 1-11. Thus, the same reference numbers will be used in this exemplary embodiment to indicate elements that are similar in the embodiments shown in FIGS. 1-11.

Smart technology may be included in each of the exemplary embodiments. For example, a user may be able to regulate the refrigerator 3 such as by turning it on and off remotely by a remote device 217. The remote device 217 may be a hand held device such as a cellular phone. The cell phone may also be a smart phone. A charging pad 219 (FIG. 14) may be provided on the microwave oven 2 or other suitable place to receive the smart phone for charging the smart phone. For example, a wireless charging pad 219 may be placed on top 225 of the microwave oven 2 for recharging the smart phone. The charging pad 219 may be built into the top 225 of the microwave oven 2 or be a separate piece that is mounted to the top 225 of the microwave oven 2. The charging pad 219 includes a recessed area 220 for receiving an item to be charge such as the smart phone. The charging pad 219 may include a wireless connection 221 for the remote control device 217 for controlling the microwave or refrigerator such as turning off or on the microwave oven 2 and/or refrigerator 3. USB ports 223, 224 may be provided in the charging pad 219. Alternatively, or in addition, power outlets may be provided in the charging pad 219. Alternatively, the charging pad 219 may be provided on the front, side, rear or bottom of the microwave oven 2.

As seen in FIGS. 16, 18, and 20, a safety sensor 226 such as a smoke or gas sensor may be provided in the microwave oven 2. The smoke sensor 226 operates to turn off the microwave oven upon sensing smoke or polluted air indicative of a dangerous condition such as the microwave being on fire. The safety sensor 226 may be powered on when the

microwave oven is in operation. The sensor 226 may be an alcohol sensor that is coupled with a thermistor 228. The alcohol sensor 226 may operate in the temperature range of 32 to 104 degrees Fahrenheit. When abnormal heating is sensed by the thermistor 228, the thermistor 228 causes the alcohol sensor 226 to turn on and check the gas.

If the alcohol sensor 226 senses polluted air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor to the microcontroller 104. Upon receiving the shutdown signal, the microcontroller 104 determines that the microwave oven 2 should be shut down and causes the microwave to shutdown. If (after the alcohol sensor is caused to be turned on by the thermistor) the alcohol sensor 226 senses air that is not indicative of a dangerous condition such as the air produced by normal cooking of food in the microwave oven 2, the alcohol sensor will not send a shutdown signal to the microcontroller 104.

Alternatively or in addition, a fault indicator 230 may be coupled to the microcontroller 104 or other circuitry to indicate that there is a dangerous condition upon detection by the alcohol sensor 226. For example, the fault indicator 230 may be a buzzer that is activated in response to the alcohol sensor 226 sensing polluted air indicative of a dangerous condition. In another example, fault indicator 230 may include the display 124 displaying a fault message such as "E-1" in response to the alcohol sensor 226 detecting polluted air indicative of a dangerous condition.

The embodiment may include a combination of fault indicators. For example, upon the alcohol sensor 226 sensing air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor 226 to the microcontroller 104. Upon receiving the shutdown signal, the microcontroller 104 determines that the microwave oven 2 should be shut down and causes the microwave oven 2 to shutdown. In addition, a buzzer is activated and the display 124 displays a fault message such as "E-1" in response to the alcohol sensor 226 sensing polluted air indicative of a dangerous condition.

The alcohol 226 sensor may be reset automatically upon the alcohol sensor 226 not detecting gas indicative of the dangerous condition. Alternatively or in addition, the alcohol sensor 226 may be reset upon opening of the microwave door 9 of the microwave oven 2. The display may display a "bar" or other suitable icon to indicate that the alcohol sensor 226 is turned on. Other types of suitable safety sensors may also be used instead of the alcohol sensor to detect a dangerous condition.

As seen in FIGS. 15 and 16, the front control panel 22 of the microwave oven 2 may include Universal Serial Bus (USB) ports 232, 234 for connection, communication, and power supply between the front control panel 22 and electronic devices such as a personal computer, cell phone, iPod®, iPad®, or other suitable device to allow communication and/or charging of the electronic device plugged into the USB ports. In one exemplary embodiment, a first USB port 232 may be provided on the upper portion 236 of the front control panel 22, and a second USB port 234 may be provided on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112 and between the reset buttons 113, 114 as seen in FIG. 15. The first USB port 232 may include a three ampere fuse and a linear time-variant system (LVT) of 100 mA, 120 volts, and 12 watts. The second USB port 234 may include a linear time-variant system (LVT) of 200 mA, 120 volts, and 24 watts. The second USB port 234 may also be reset. The current sensor 118 may be constructed to limit the second USB port and the two auxiliary outlets to 12 amps. The USB ports 232, 234

may be in operative connection with respective printed circuit boards. Alternatively or in addition, one or more USB ports may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively or in addition, one or more auxiliary outlets may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively, the refrigerator outlet may be provided on the top, bottom, or one of the sides of the microwave oven.

FIGS. 17 and 18 show another exemplary arrangement of the USB ports 232, 234. In this arrangement, the first and second USB ports 232, 234 are located side by side on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112. The USB ports 232, 234 are also located rightwardly (as viewed in FIG. 17) adjacent a status LED indicator and reset button 240. In this exemplary arrangement, current sensor 218 is connected to monitor the combined current in the USB ports 232, 234 and the auxiliary outlets 111 and 112. The current sensor 218 is constructed to limit the combined current in the USB ports and auxiliary outlets 111 and 112 to 12 amperes. The LED indicator and reset button 240 may light on when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and flash when disabled. In another embodiment, the LED indicator and reset button 240 may be off when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and light on or flash when disabled. Depressing the LED indicator and reset button 240 enables the auxiliary outlets 111, 112 and the USB ports 232, 234 so that power may be supplied to them when the combined current in them falls from above to below the limit.

FIGS. 19 and 20 show an alternative arrangement in which one USB port 234 is located above the auxiliary outlets 111, 112 and rightwardly adjacent the status LED indicator and reset button 240. In this exemplary arrangement, the current sensor 218 is connected to monitor the combined current in the USB port 234 and auxiliary outlets 111 and 112. The current sensor 218 is constructed to limit the combined current in the USB port 234 and auxiliary outlets 111 and 112 to 12 amperes. Alternatively, the current sensor 218 may be constructed to limit the combined current in the USB port 234 and the auxiliary outlets 111 and 112 to 13 amperes. The LED indicator and reset button 240 may light on when power to the auxiliary outlets 111, 112 and the USB port 234 is available and flash when disabled. In another embodiment, the LED indicator and reset button 240 may be off when power to the auxiliary outlets 111, 112 and the USB port 234 is available and light on or flash when disabled. Depressing the LED indicator and reset button 240 enables the auxiliary outlets 111, 112 and the USB port 234 so that power may be supplied to them when the combined current in them falls from above to below the limit. All other elements of the embodiments of FIGS. 17-20 are similar in structure and function as the embodiment shown in FIGS. 1-11. Thus, the same reference numbers will be used in this exemplary embodiment to indicate elements that are similar in the embodiments shown in FIGS. 1-11.

FIG. 21 shows the rear portion 244 of the microwave oven for the embodiments shown in FIGS. 12-20. Refrigerator outlet 15 is shown to be provided on and accessible from the rear portion 244 of the microwave oven and is associated with the LED indicator and reset button 214, which is also provided on the rear portion 244 of the microwave oven. FIG. 22 is a similar view as FIG. 21 except that AC cord 8 for the microwave oven is shown.

In the embodiments shown in FIGS. 12-22, control models may be established for execution by the controller or microprocessor 4. These models can be in the form of algorithms stored in a computer readable medium, such as software or firmware within the microprocessor 104. The models or scenarios are, in the first instance, dependent on the state of operation of the microwave oven 2. The current demands of the microwave oven 2 are generally the most significant contribution to overload. To avoid overload conditions, power to the low power receptacles or auxiliary outlets, refrigerator receptacle, and/or USB ports is disabled during microwave operation.

FIG. 23 shows a flow chart illustrating several control models or scenarios. The microprocessor 104 begins by determining whether the microwave oven is turned on or operating in step 246. When the microwave oven is turned on or operating, the rear refrigerator outlet 15, the two auxiliary outlets 111, 112 on the front control panel 22, and the two USB ports 232, 234 on the front control panel are all turned off or disabled, so that the total draw of current for the combination microwave and refrigerator is not over 15 amperes as indicated in step 248.

When the microwave oven is not operating and items are plugged into the two USB ports 232, 234, two auxiliary outlets 111, 112, and rear refrigerator outlet 15, then the microprocessor 104 determines whether the refrigerator outlet 15 is drawing less than 2 amperes (approximately the average amperes when the refrigerator is running) in step 250. If the refrigerator outlet 15 is drawing less than 2 amperes, then all the outlets 15, 111, 112 and USB ports 232, 234 are enabled, so that power may be supplied to them as indicated in step 252. If the refrigerator outlet 15 not drawing less than 2 amperes, the microprocessor 104 determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 254. If the refrigerator outlet 15 is drawing less than 14 amperes but not less than or greater than or equal to 2 amperes, then the auxiliary outlets 111, 112 and USB ports 232, 234 are disabled or turned off so that no power may be supplied to them as indicated in step 256. The refrigerator outlet 15 remains enable. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 is disabled in step 258. This may be accomplished by tripping the relay 20 of the reset circuit off. In addition, the red LED light on the LED indicator and reset button 214 is turned on to identify the disablement condition of the refrigerator. Then, in step 260, the auxiliary outlets 111, 112 and USB ports 232, 234 are enabled so that power may be supplied to them.

Then, the microprocessor determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 262. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 remains disabled and the red LED light on the LED indicator and reset button 214 remains turned on to identify the disablement condition of the refrigerator 3. This condition may occur, for example, if an electrical heater is plugged into the refrigerator outlet 15. When the refrigerator outlet 15 draws less than 14 amperes resulting from the overload condition being eliminated, the refrigerator outlet 15 will be enabled so that power may be supplied to the refrigerator outlet 15 upon the LED indicator and reset button 214 being depressed as indicated in step 264. Depressing of the LED indicator and reset button 214 in this condition will also turn off the red LED light. The

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process then ends. It should be noted that the microprocessor 104 can make the determination in steps at the same time or in a different order.

It should be understood that the above description is only illustrative of the invention. Various alternatives and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

What is claimed is:

1. A system of linked appliances comprising:
 - a microwave oven connected to a source of power and having a control circuit for controlling the operation of the microwave oven;
 - a first power supply outlet provided on the microwave oven;
 - a refrigerator connected to the source of power by connection to the first power supply outlet;
 - a second power supply outlet connected to the source of power through the control circuit, the second power supply outlet adapted to be electrically connected to at least one device having lower power consumption requirements than power requirements of the refrigerator;

sensing components connected to sense current draw at the second power supply outlet, and generating signals indicative thereof;

wherein the control circuit is configured to enable or disable power to the microwave oven, the first power supply outlet and the second power supply outlet, and wherein the control circuit:

disables the refrigerator and the second power supply outlet, when the microwave oven draws cooking power; and

enables the second power supply outlet when the microwave oven does not draw cooking power; and

wherein the microwave oven includes a front portion, wherein the front portion includes a door and a front control panel, wherein the front control panel includes the second power supply outlet, wherein the second power supply outlet includes at least one USB port which is not electrically powered and inoperative when the microwave oven draws cooking power.

2. The system according to claim 1 wherein the control circuit further disables the second power supply outlet when signals generated by the sensing components indicate current draw at the second power supply outlet in excess of a predetermined limit.

3. The system according to claim 2, and further comprising a visible indicator on the front control panel, wherein the visible indicator changes visible condition responsive to the second power supply outlet being electrically disabled or enabled.

4. The system according to claim 3 and further comprising a manual input device on the front control panel, wherein the control circuit causes the second power supply outlet to remain disabled after the predetermined limit is exceeded, until at least one input is received through the manual input device.

5. The system according to claim 1, wherein the control circuit starts a timer clock when the refrigerator is disabled and prevents the subsequent enabling of the refrigerator before the expiration of a predetermined time limit.

6. The system according to claim 5, wherein the predetermined time period is three minutes.

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7. The system according to claim 1, wherein the second power supply outlet includes at least two USB ports configured when electrically enabled to provide power to charge battery operated electronic devices, and wherein the sensing components are operative to sense the current demanded at each of the USB ports.

8. The system according to claim 1, wherein the sensing components further include

a first current sensor operative to monitor current draw on the first power supply outlet, and

a second current sensor operative to monitor current draw on the second power supply outlet,

wherein the control circuit, responsive to the first and second current sensors is configured to make a determination that total combined current draw on the first and second power supply outlets exceeds a predetermined value, wherein the control circuit is operative to disable power to the first and second power supply outlets responsive to the determination.

9. The system according to claim 8

wherein the front control panel includes a first reset input device and a second reset input device,

wherein the control circuit is operative to restore electrical power to the disabled first power supply outlet responsive to an input to the first reset input device, and to the disabled second power supply outlet responsive to another input to the second input device.

10. The system according to claim 9

wherein the front control panel includes a first visual indicator associated with the first power supply outlet and a second visual indicator associated with the second power supply outlet,

wherein the first visual indicator gives a visual indication when the first power supply outlet is disabled and the second visual indicator gives the visual indication when the second power supply outlet is disabled.

11. The system according to claim 1,

wherein the second power supply outlet comprises at least one AC outlet and the at least one USB port;

wherein the sensing components further include a first current sensor operative to monitor current draw on the first power supply outlet and a second current sensor operative to monitor total combined current draw on the at least one AC outlet and the at least one USB port, wherein the control circuit is configured to limit the total combined current draw on the at least one AC outlet and the at least one USB port to no more than a predetermined value.

12. A system of linked appliances comprising:

a microwave oven connected to a source of power and having a control circuit for controlling the operation of the microwave oven;

a first power supply outlet provided on the microwave oven;

a refrigerator connected to the source of power by connection to the first power supply outlet;

a second power supply outlet connected to the source of power through the control circuit, the second power supply outlet adapted to be electrically connected to at least one device having lower power requirements than power requirements of the refrigerator;

sensors connected to sense current demanded at the second power supply outlet, and generating signals indicative thereof;

wherein the control circuit is configured to enable or disable power to the microwave oven, the first power

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supply outlet and the second power supply outlet, and wherein the control circuit:

disables the refrigerator and the second power supply outlet, when the microwave oven draws cooking power; and

enables the second power supply outlet when the microwave oven does not draw cooking power; and wherein the microwave oven includes a front portion and a rear portion, wherein the front portion includes the second power supply outlet, wherein the second power supply outlet includes a USB port that is not operative when the microwave oven draws cooking power, and wherein the rear portion includes the first power supply outlet.

13. The system according to claim 12 wherein the control circuit further disables the second power supply outlet when the signals indicate current through the second power supply outlet exceeds a predetermined limit.

14. The system according to claim 13 wherein the second power supply outlet includes at least one AC outlet and at least one USB port.

15. The system according to claim 13

wherein the front portion includes at least one visual indicator and at least one input device,

wherein the at least one visual indicator visually indicates when the second power supply outlet is enabled or disabled, and

the control circuit is operative to reinstate power to the disabled second power supply outlet responsive to an input to the at least one input device.

16. The system according to claim 15,

wherein the control circuit is operative to disable the first and second power supply outlets when total cumulative power through the first and second power supply outlets exceeds a limit,

wherein the front portion includes a further visual indicator operative to indicate that the first power supply outlet is disabled, and a further input device, wherein a further manual input to the further input device is operative to cause the control circuit to restore power to the disabled first power supply outlet.

17. A system of linked appliances comprising:

a microwave oven connected to a source of power and having a control circuit operative to control the operation of the microwave oven;

a first power supply outlet operatively connected to the source of power through operation of the control circuit;

a refrigerator connected to the source of power by connection to the first power supply outlet;

a second power supply outlet operatively connected to the source of power through operation of the control circuit, wherein the second power supply outlet includes at least one USB port;

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sensing components connected to sense current demanded at the second power supply outlet, and generating signals indicative thereof;

wherein the control circuit is configured to enable or disable power to the microwave oven, the first power supply outlet and the second power supply outlet, and wherein the control circuit:

disables the refrigerator and the second power supply outlet including the at least one USB port, when the microwave oven draws cooking power; and

wherein the control circuit is configured to disable the second power supply outlet including the at least one USB port, when the refrigerator is operated during refrigerator compressor startup.

18. The system according to claim 17, wherein the first power supply outlet extends on a rear face of the microwave oven and the second power supply outlet extends on a front face of the microwave oven, wherein the second power supply outlet includes at least one AC outlet and the at least one USB port.

19. The system according to claim 18,

wherein the control circuit is operative to cause power to be withdrawn from the at least one AC outlet and the at least one USB port responsive to total cumulative power draw therethrough exceeding a threshold, independent of power draw through the first power supply outlet.

20. The system according to claim 19,

wherein the control circuit is operative to cause power to be withdrawn from all of the first power supply outlet, the at least one USB port and the at least one AC outlet, responsive to total cumulative power draw through all of such first power supply outlet, at least one USB port and at least one AC outlet, exceeding a further threshold.

21. The system according to claim 20, wherein the front face includes

a first visual indicator operative to visually indicate that power has been withdrawn from the first power supply outlet, and

a second visual indicator operative to visually indicate that power has been withdrawn from at least one of the at least one USB port and the at least one AC outlet.

22. The system according to claim 21

wherein the front face includes a first reset input device and a second reset input device,

wherein manual input to the first reset input device is operative to cause the control circuit to cause delivery of electrical power to the first power supply outlet when such first power supply outlet is currently disabled,

wherein manual input to the second reset input device is operative to cause the control circuit to cause delivery of electrical power to at least one of the at least one AC outlet and the at least one USB port, when such at least one AC outlet and USB port are currently disabled.

* * * * *

EXHIBIT 2

US Patent No. 9,791,206



US009791206B1

(12) **United States Patent**
Hall et al.

(10) **Patent No.:** **US 9,791,206 B1**
(45) **Date of Patent:** ***Oct. 17, 2017**

(54) **MULTIPLE LINKED APPLIANCE WITH
AUXILIARY OUTLET**

USPC 219/482, 483, 485, 488, 678, 679, 695,
219/697, 702, 715, 716, 717, 718, 719,
219/720, 721, 722, 723, 756, 761, 707

See application file for complete search history.

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(US)

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Primary Examiner — Hung D Nguyen

(74) *Attorney, Agent, or Firm* — Ralph E. Jocke; Walker
& Jocke

(21) Appl. No.: **15/135,873**

(22) Filed: **Apr. 22, 2016**

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filed on Apr. 25, 2014, which is a continuation-in-part
(Continued)

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H05B 6/50 (2006.01)
H05B 6/64 (2006.01)
H05B 6/66 (2006.01)
F25D 23/12 (2006.01)
H05B 6/68 (2006.01)

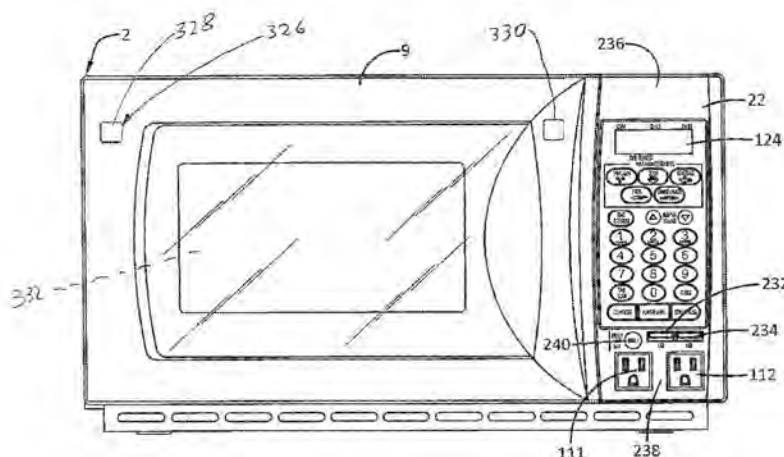
(52) **U.S. Cl.**
CPC **F25D 23/12** (2013.01); **H05B 6/666**
(2013.01); **H05B 6/68** (2013.01)

(58) **Field of Classification Search**
CPC . H05B 6/68; H05B 6/808; H05B 6/66; H05B
6/645; H05B 6/666; F25D 23/12; F25B
29/00

(57) **ABSTRACT**

An apparatus includes microwave oven and refrigerator functions. The microwave oven is connected to a source of electrical power and has at least one control circuit for controlling the operation of the microwave oven. A first power supply outlet is provided on the microwave oven. A refrigerator is connected to the source of power by connection to the first power supply outlet. The at least one control circuit is configured to disable the refrigerator compressor, when the microwave oven demands cooking power, and enable the refrigerator compressor when the microwave oven is not drawing cooking power. A safety sensor is provided in the microwave oven and is configured to cause the microwave oven to cease cooking operation upon the safety sensor sensing a dangerous condition.

12 Claims, 24 Drawing Sheets



Related U.S. Application Data

of application No. 12/317,632, filed on Dec. 23, 2008,
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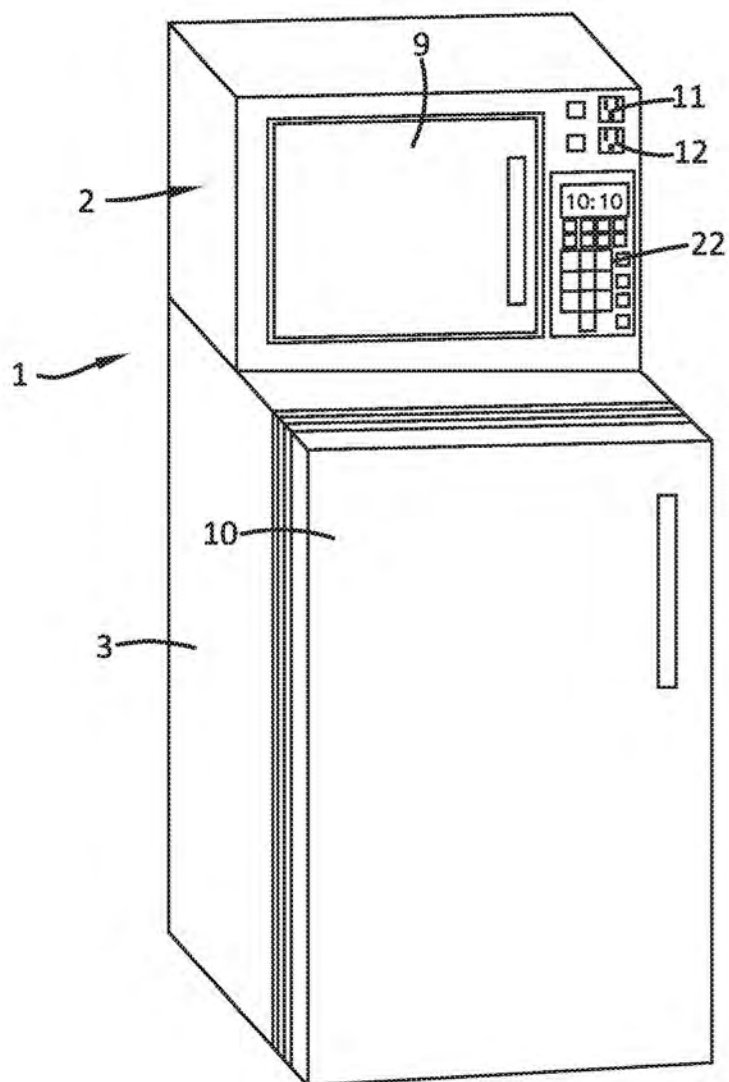


FIGURE 1

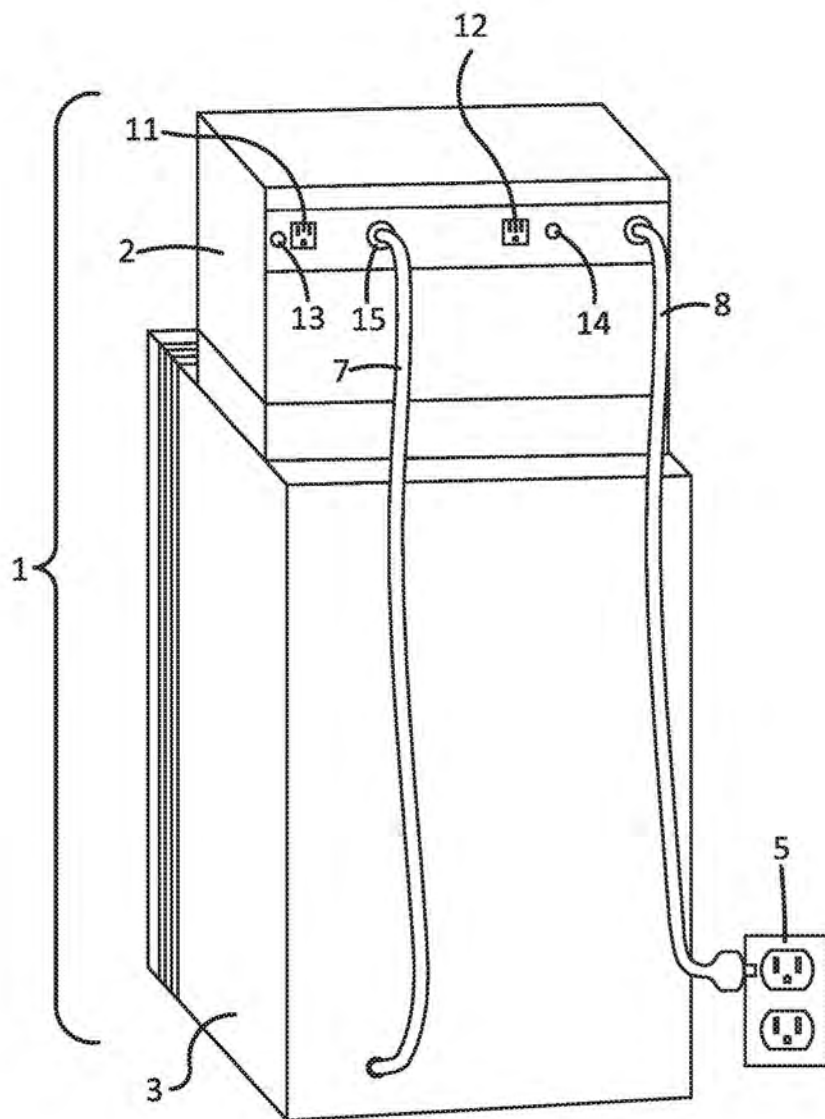


FIGURE 2

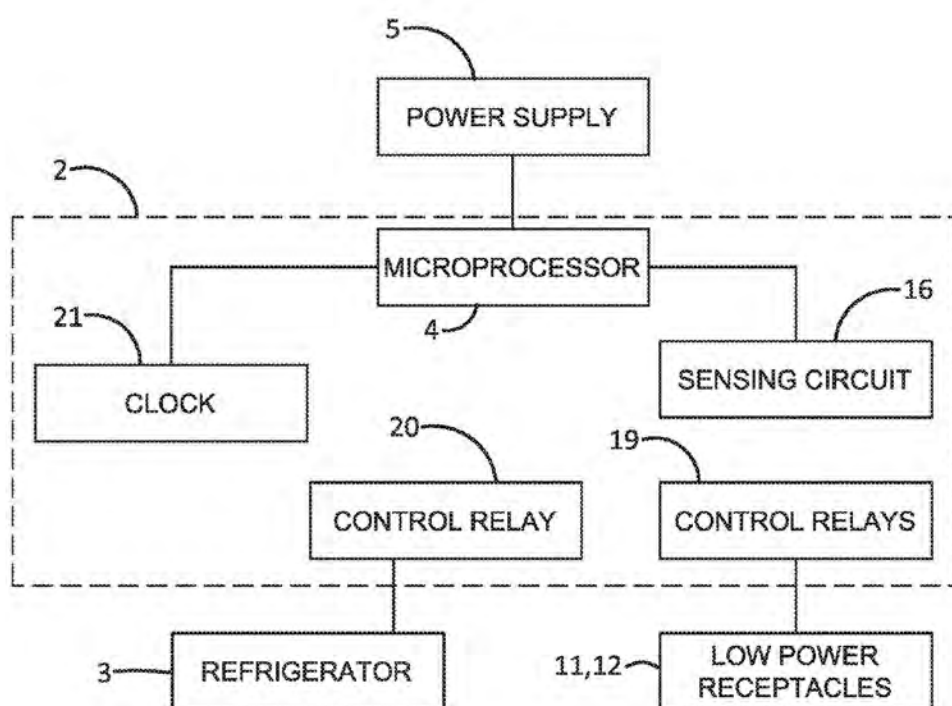


FIGURE 3

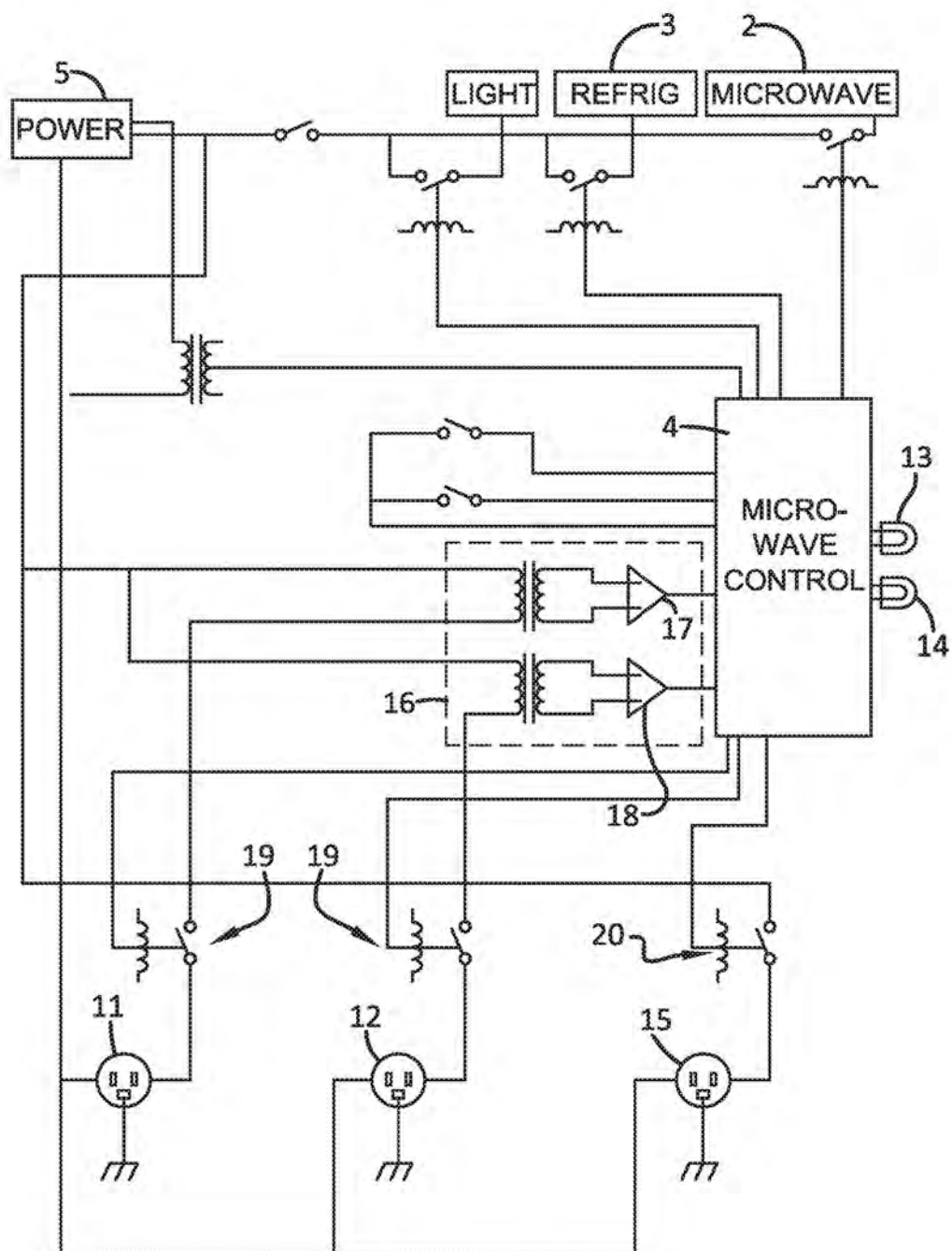


FIGURE 4

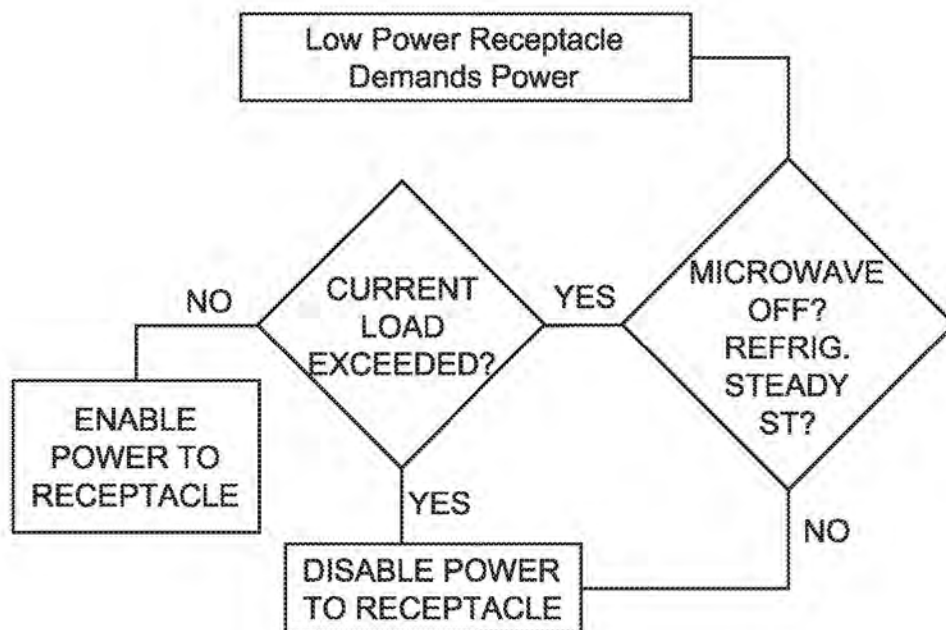


FIGURE 5

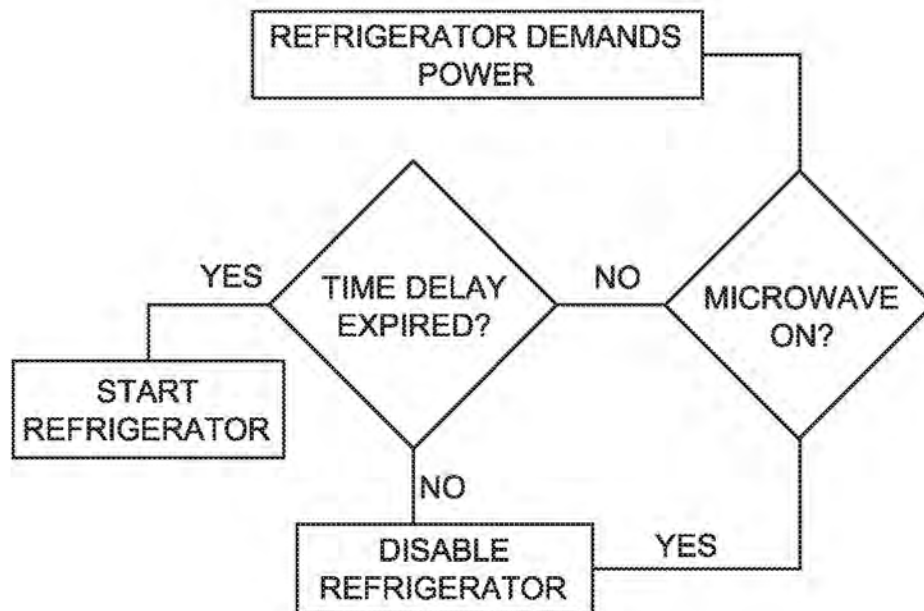


FIGURE 6

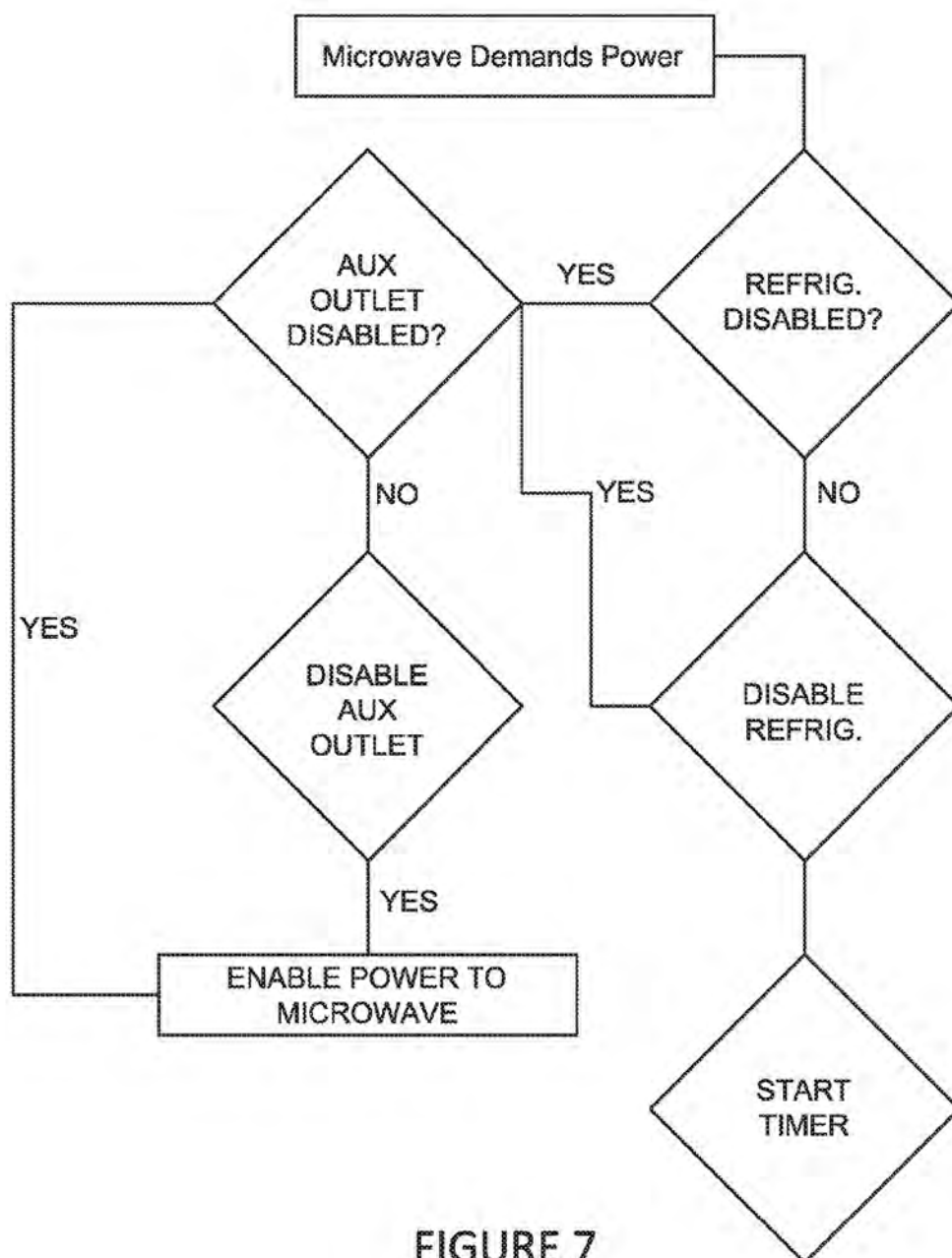


FIGURE 7

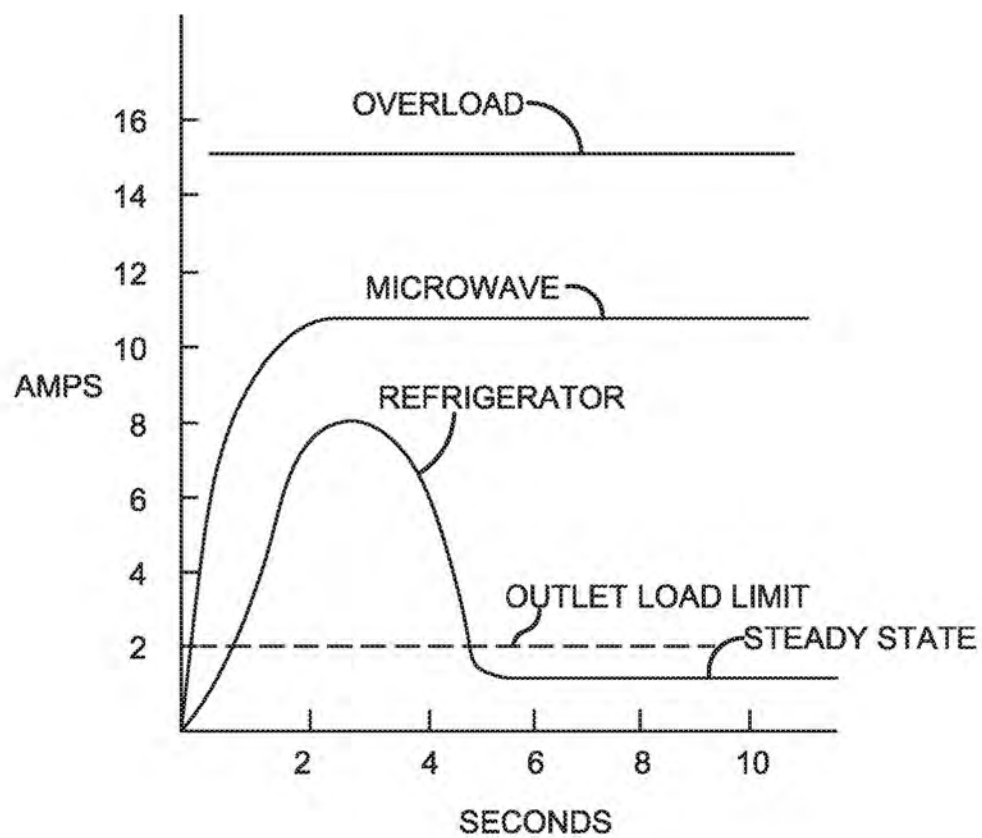


FIGURE 8

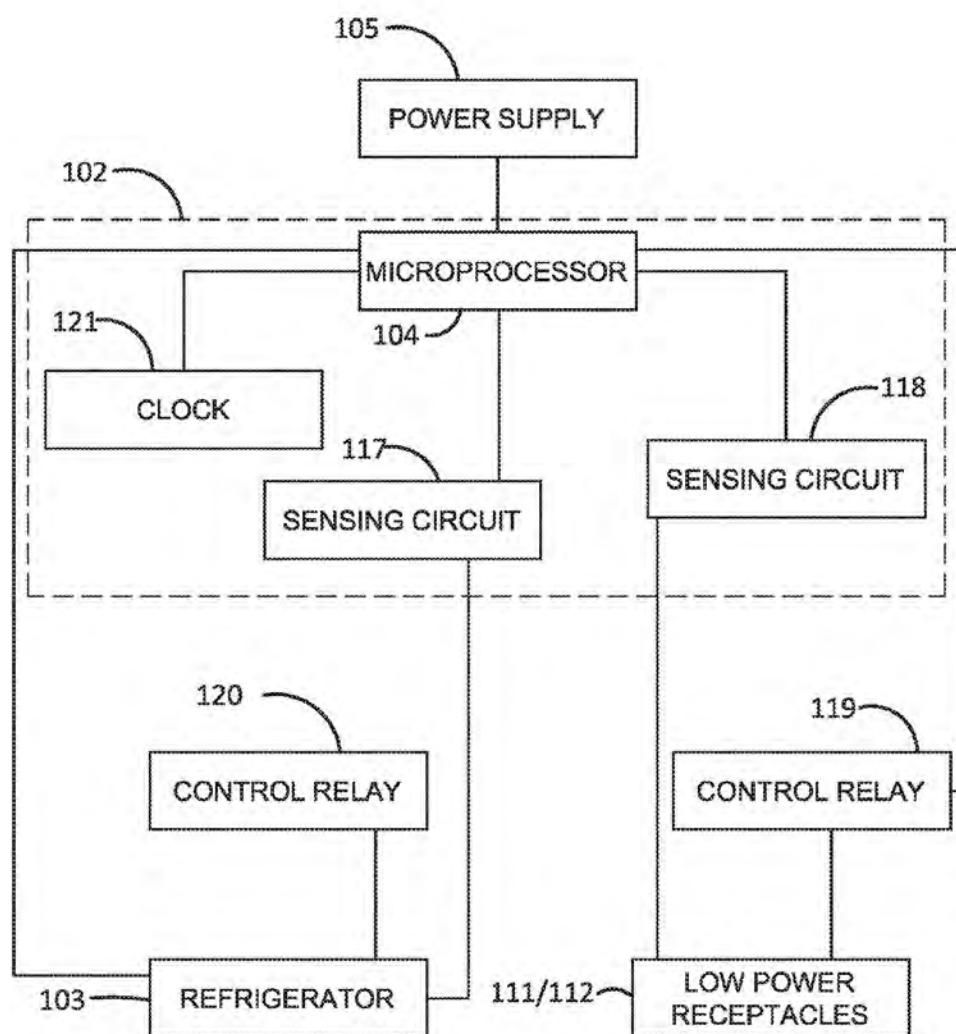


FIGURE 9

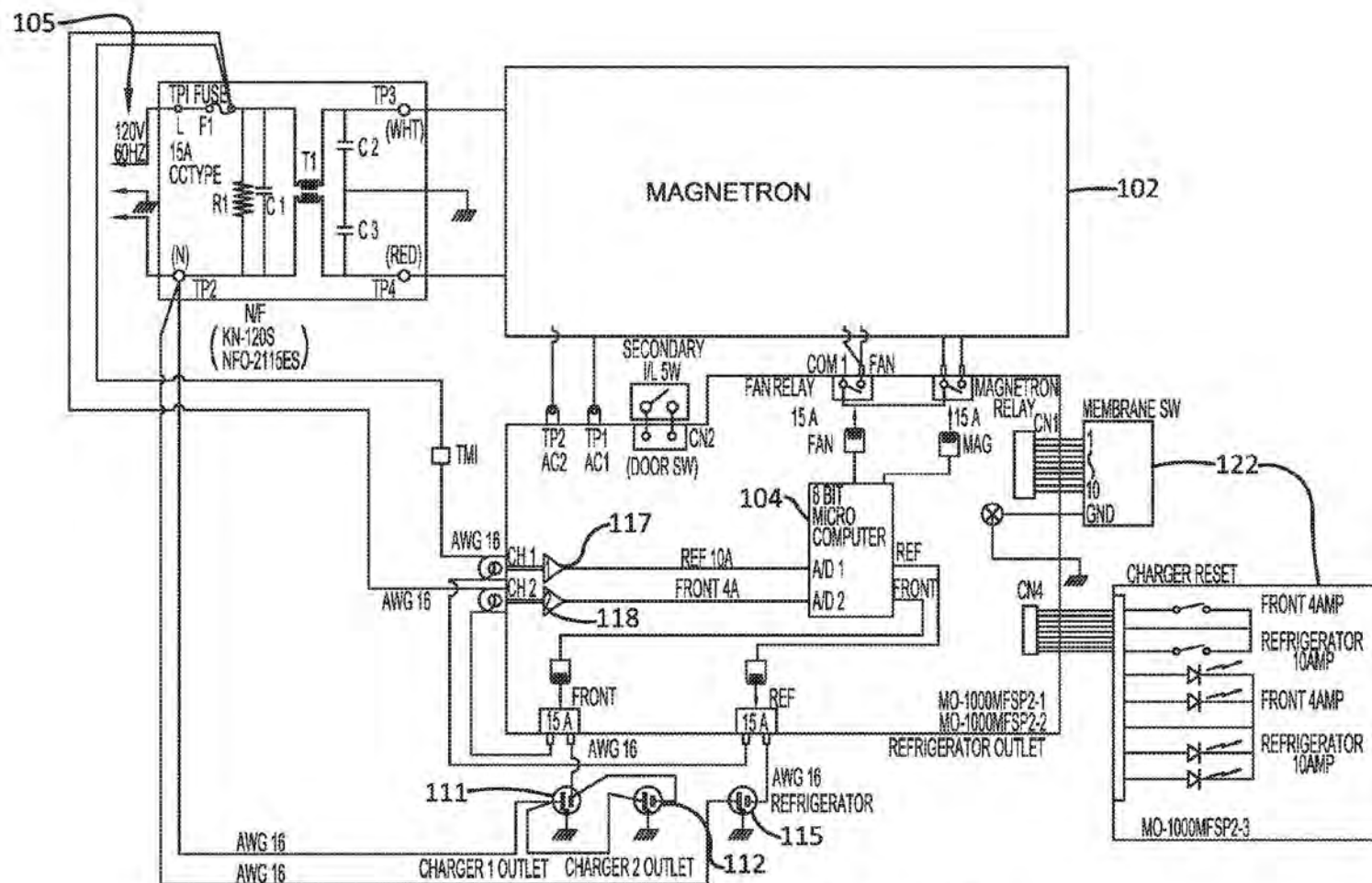


FIGURE 10

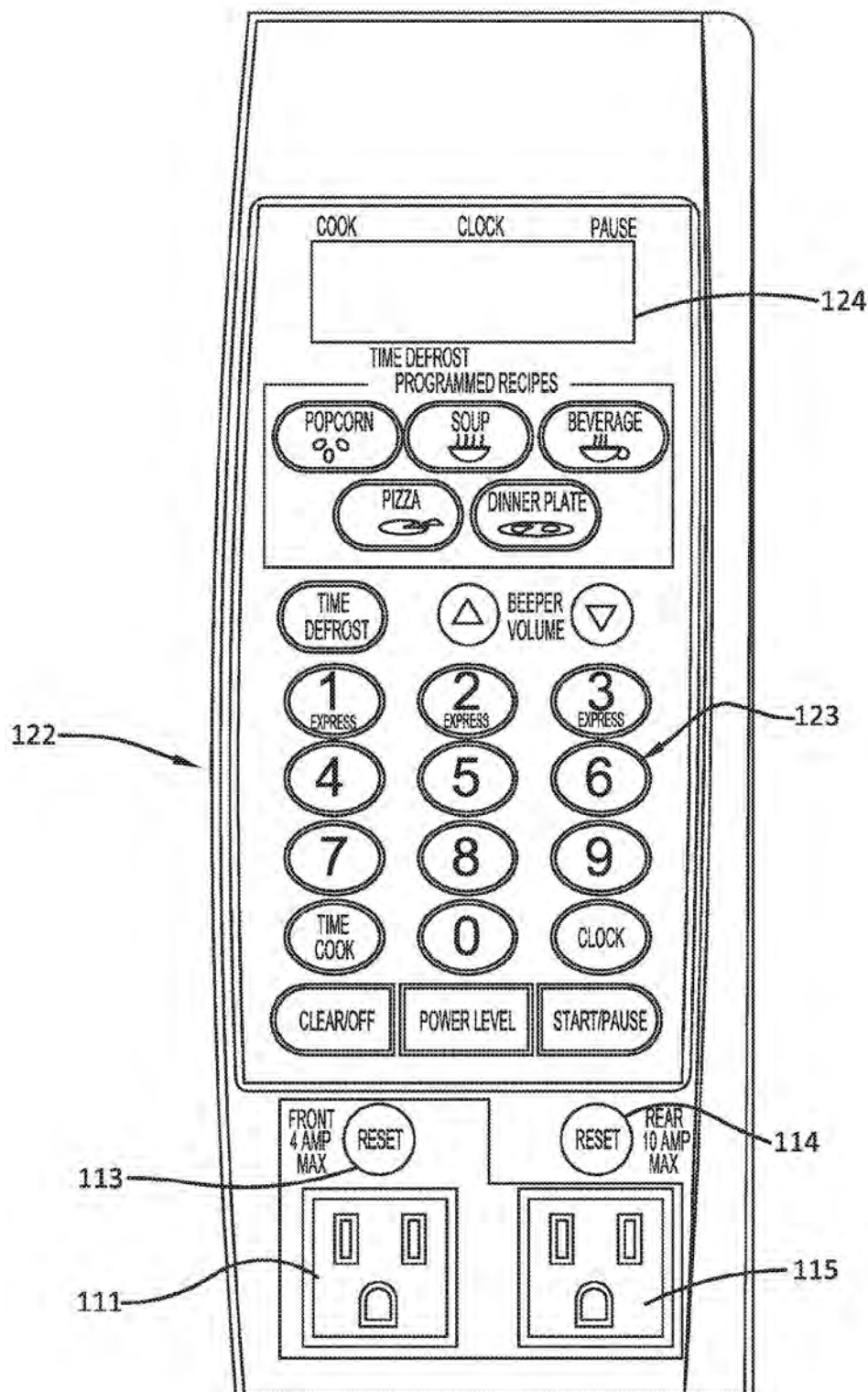


FIGURE 11

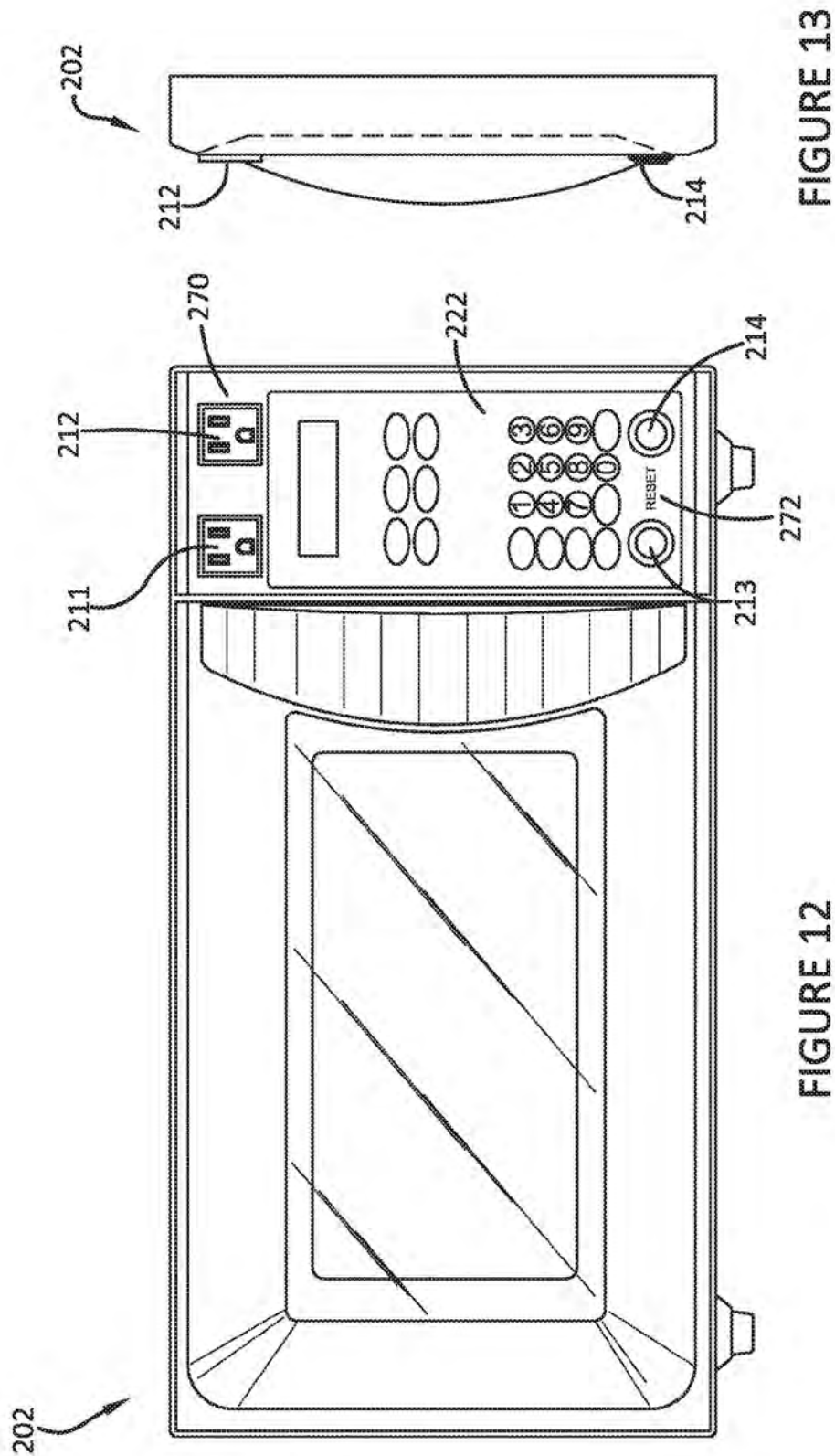


FIGURE 13

FIGURE 12

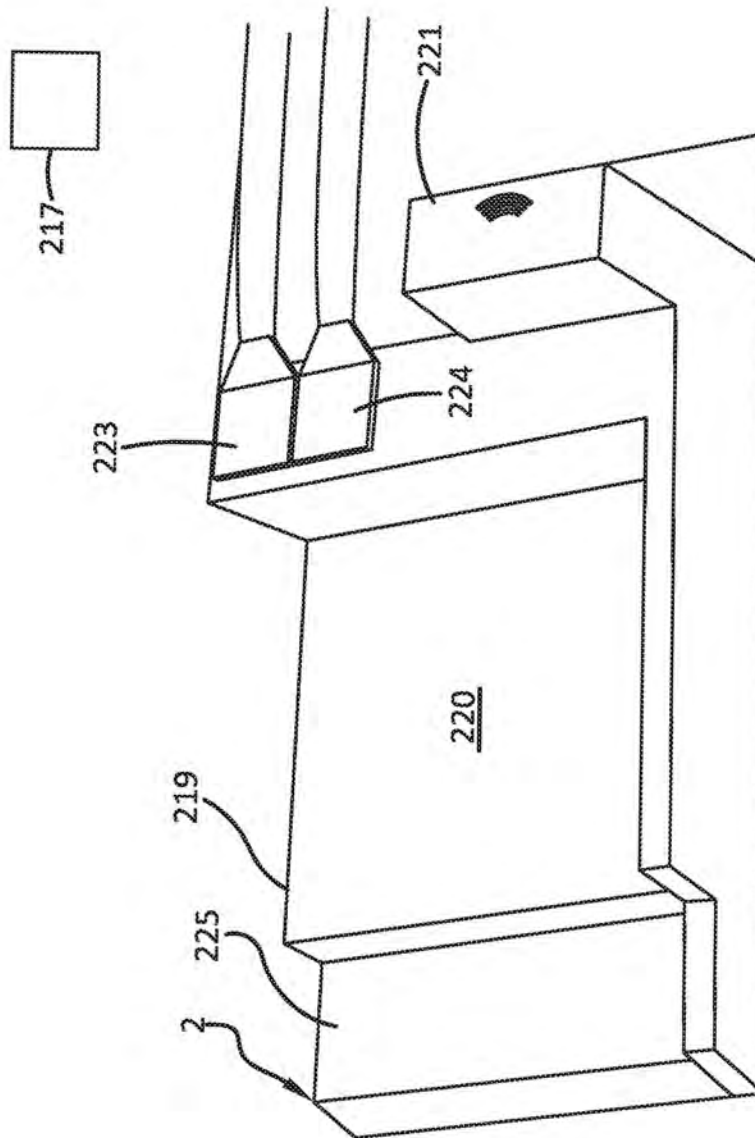


FIGURE 14

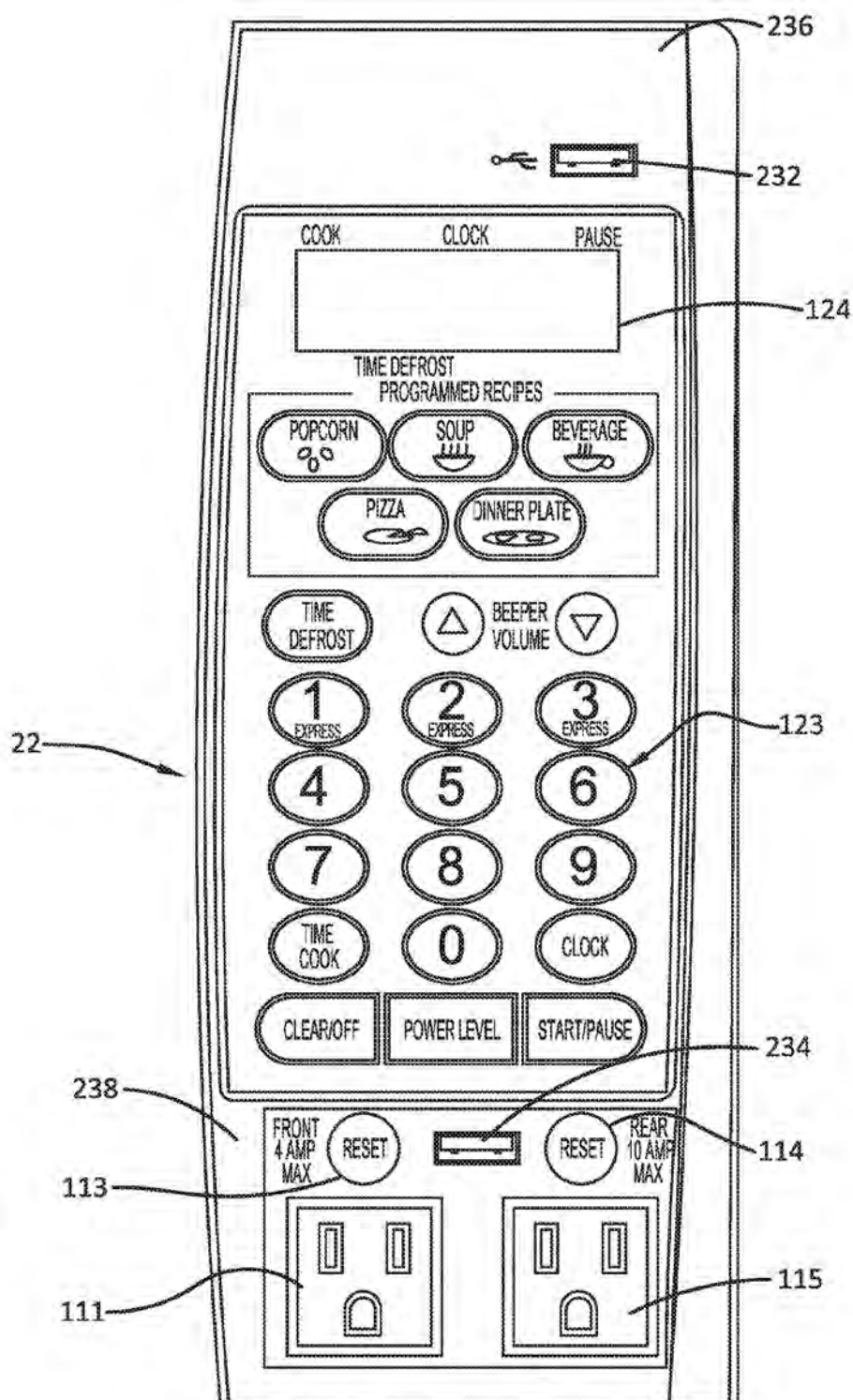
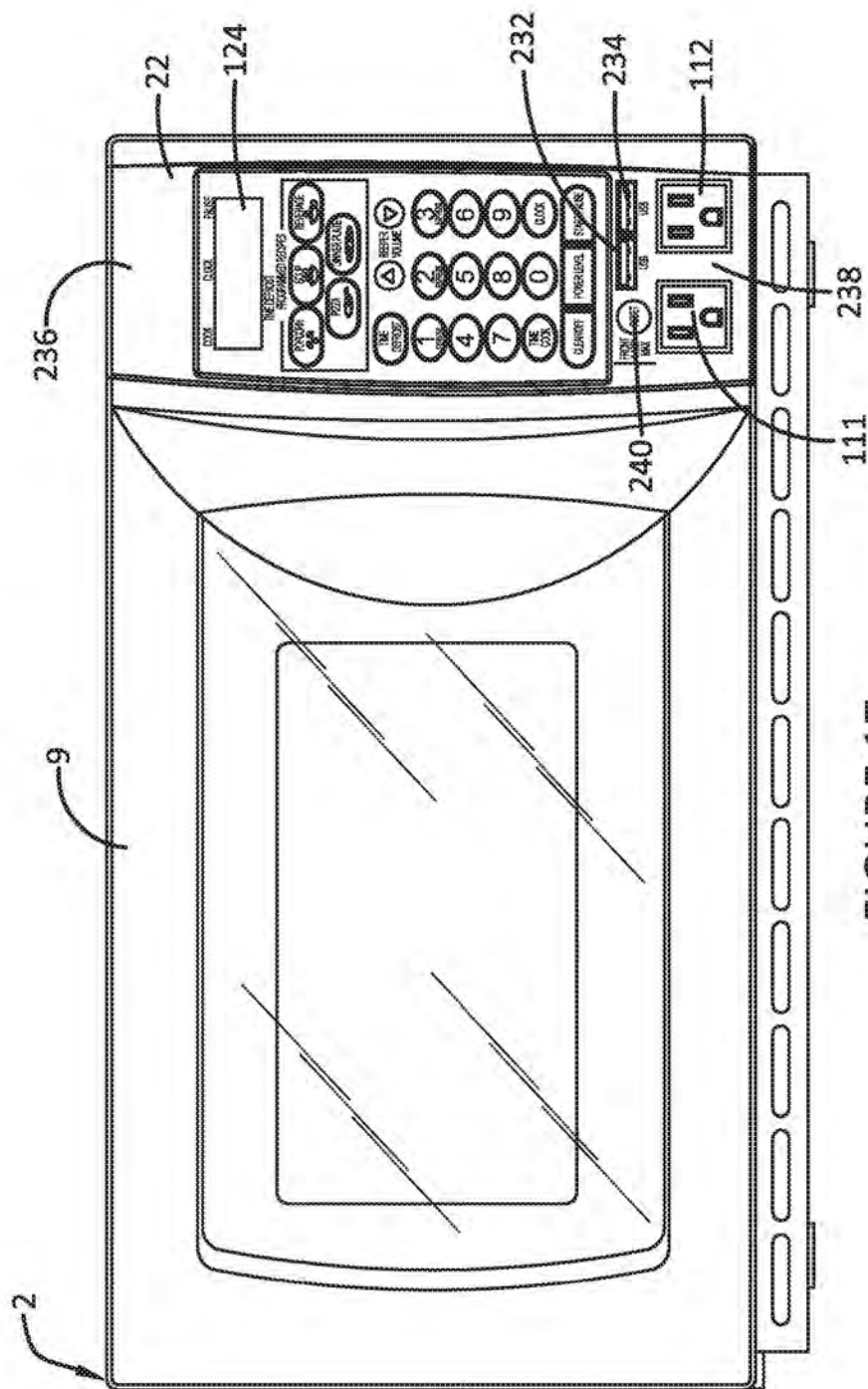


FIGURE 15



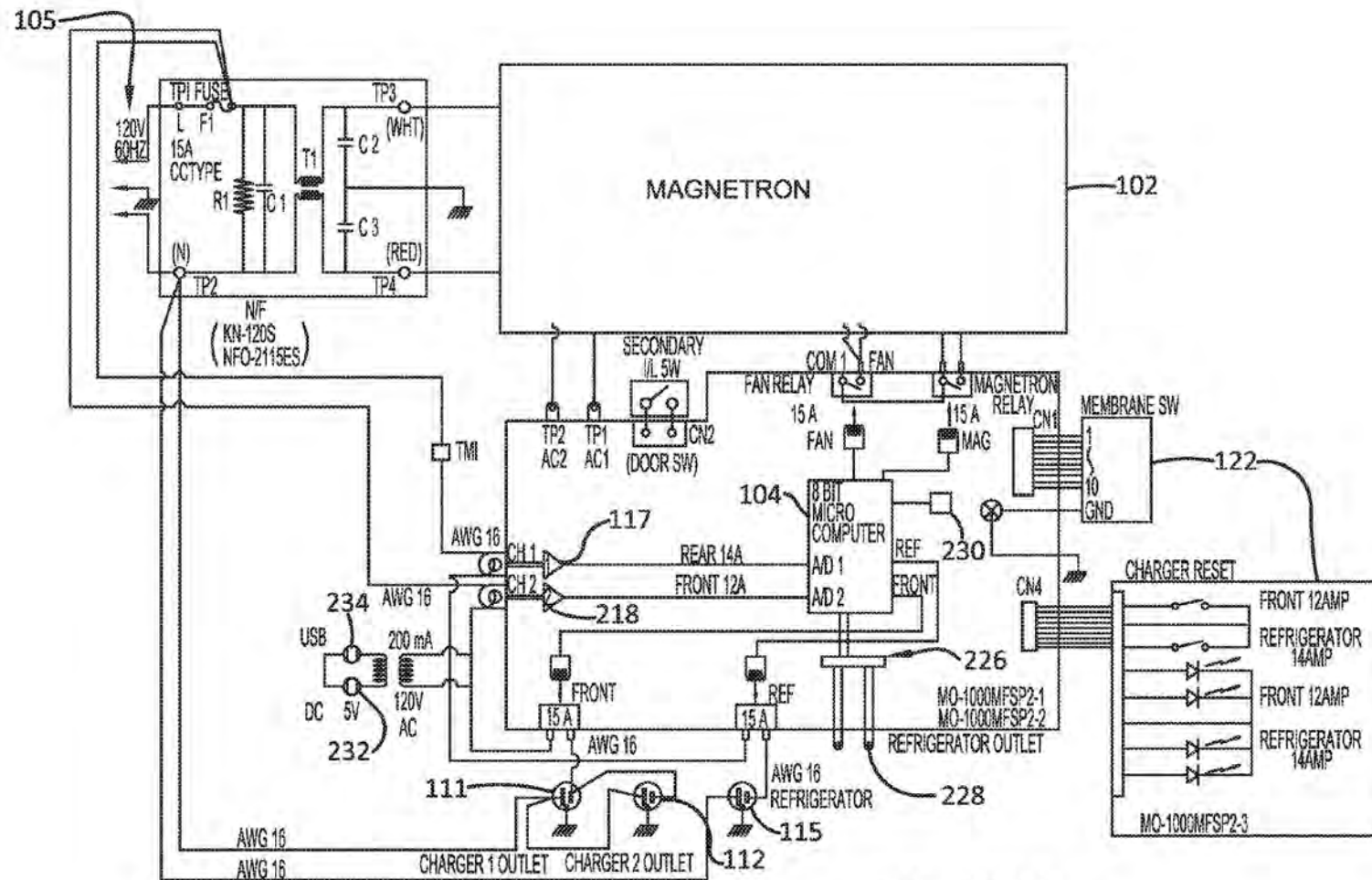


FIGURE 18

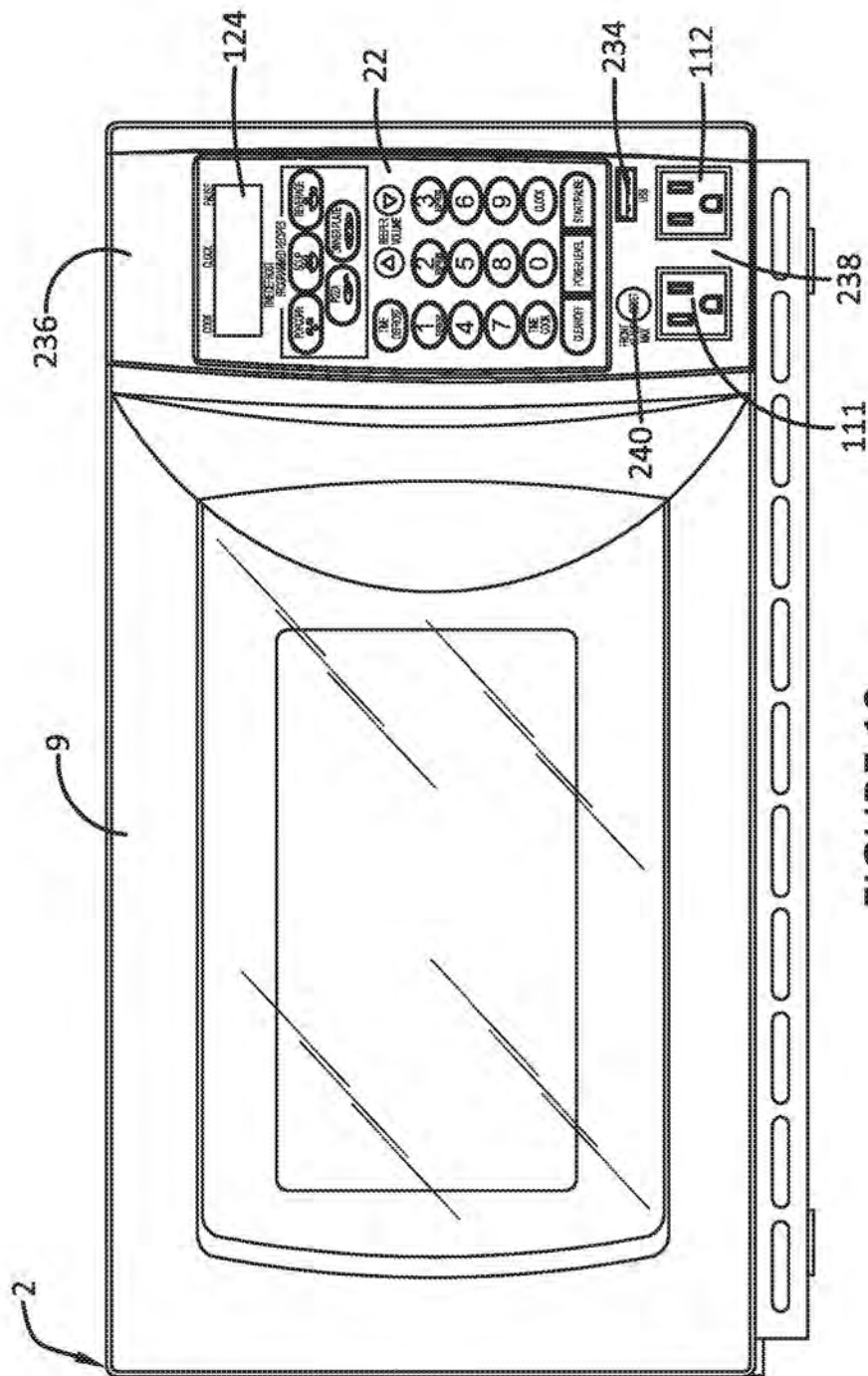


FIGURE 19

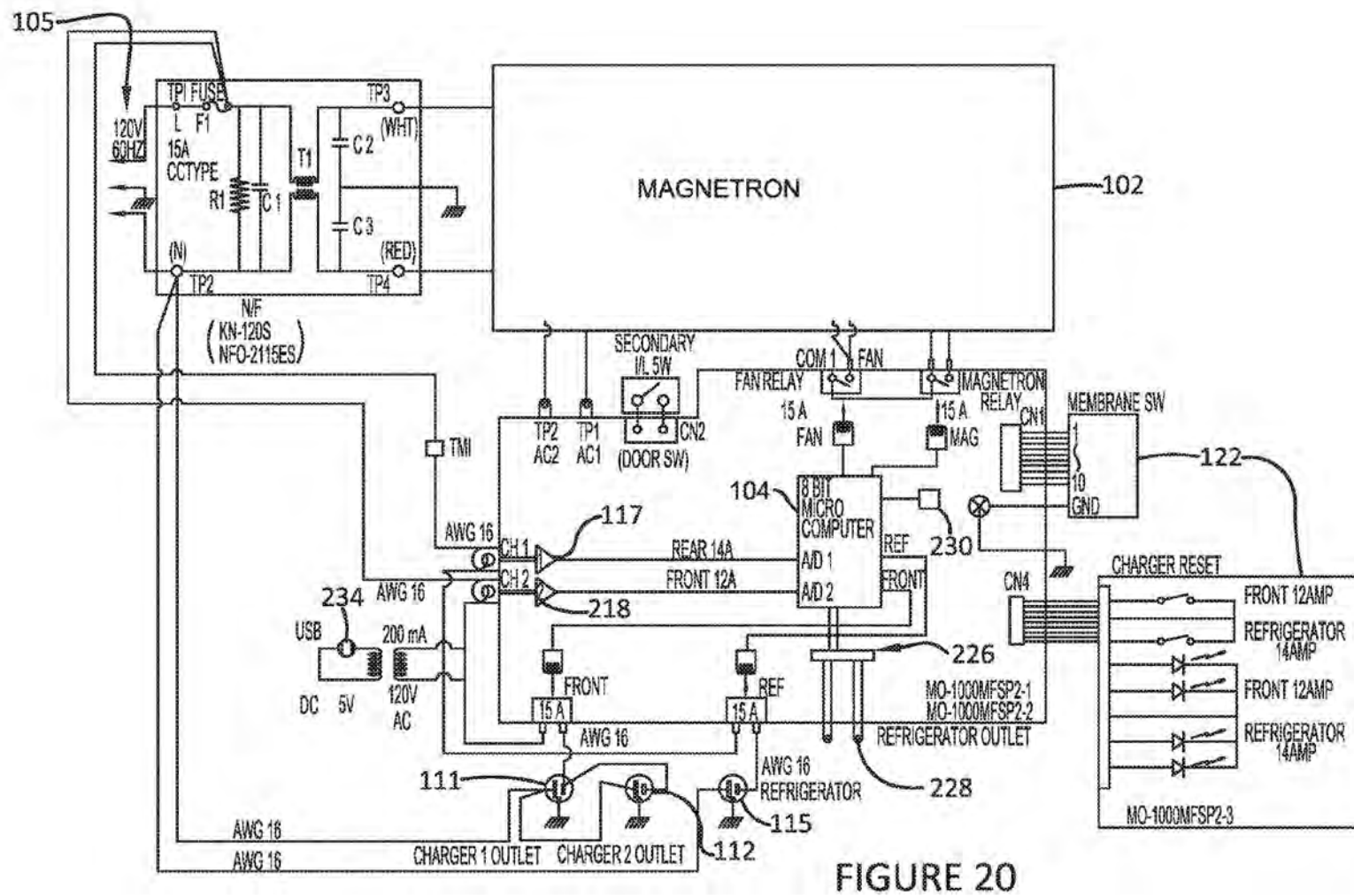


FIGURE 20

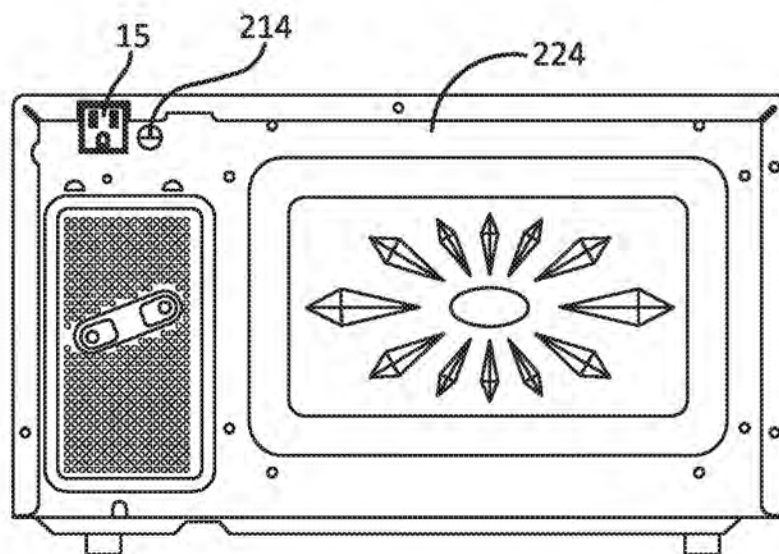


FIGURE 21

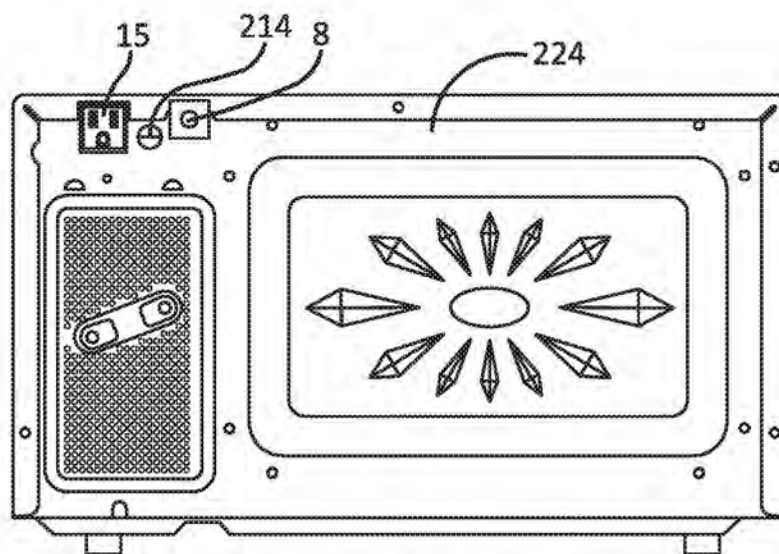


FIGURE 22

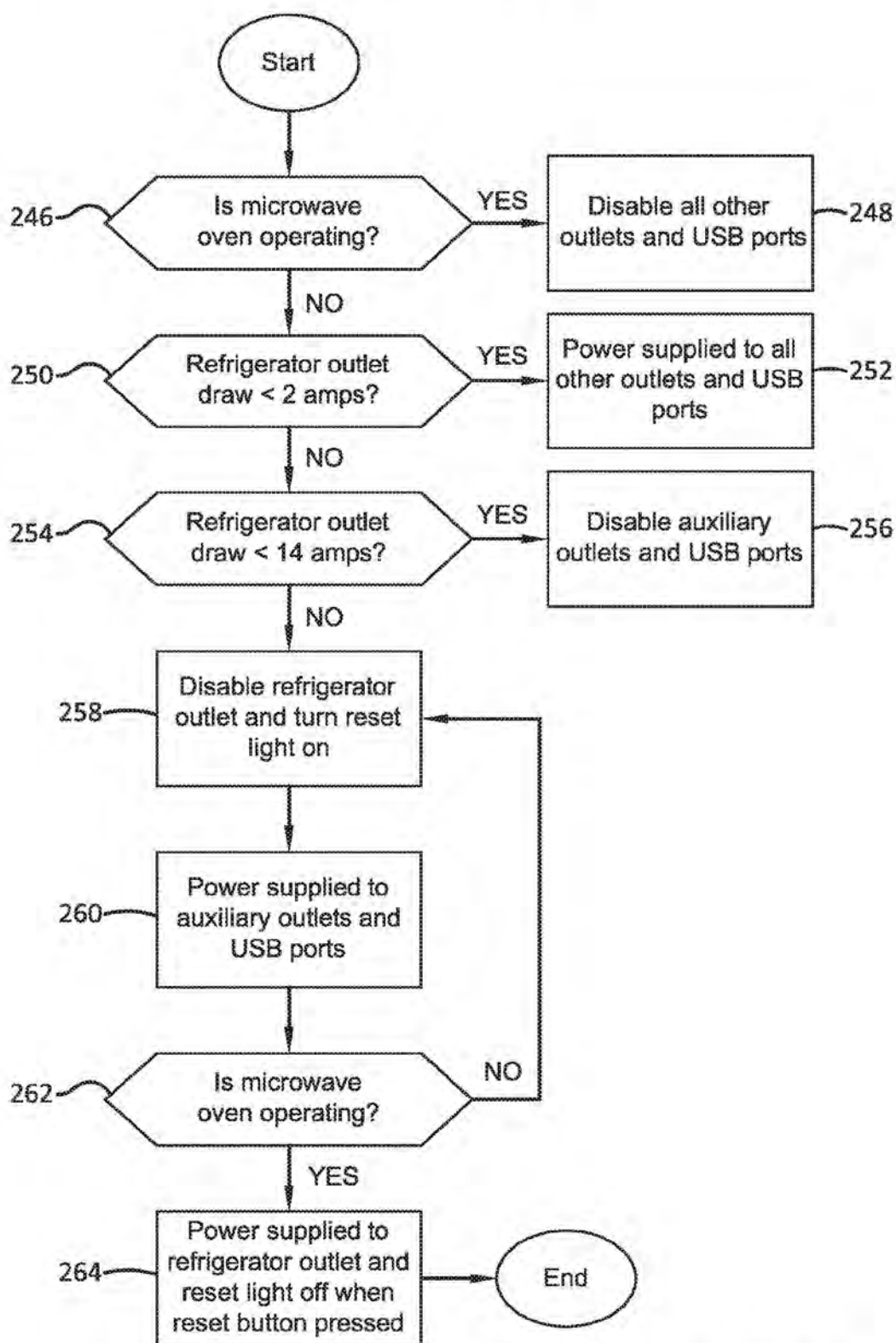


FIGURE 23

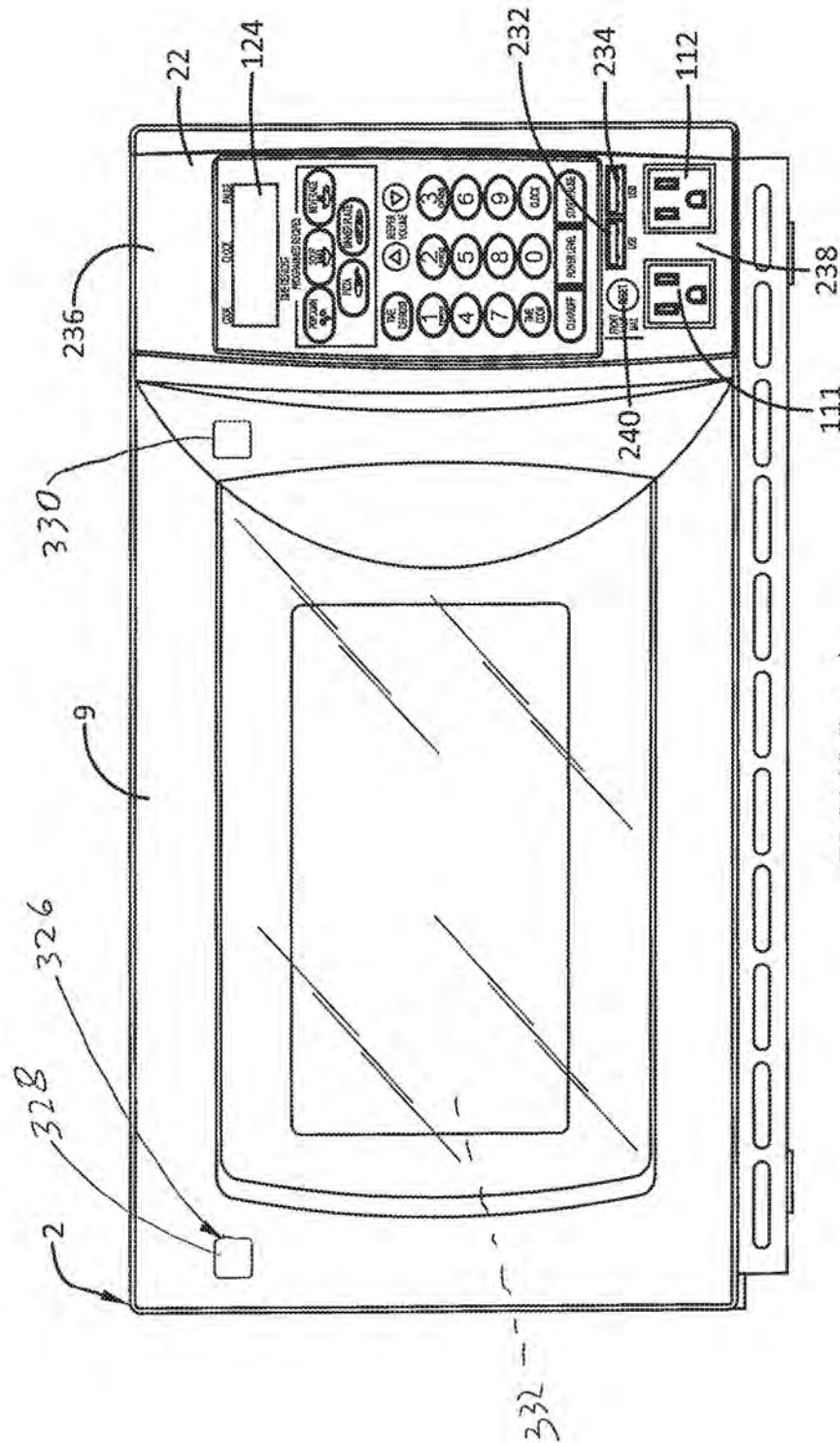


FIGURE 24

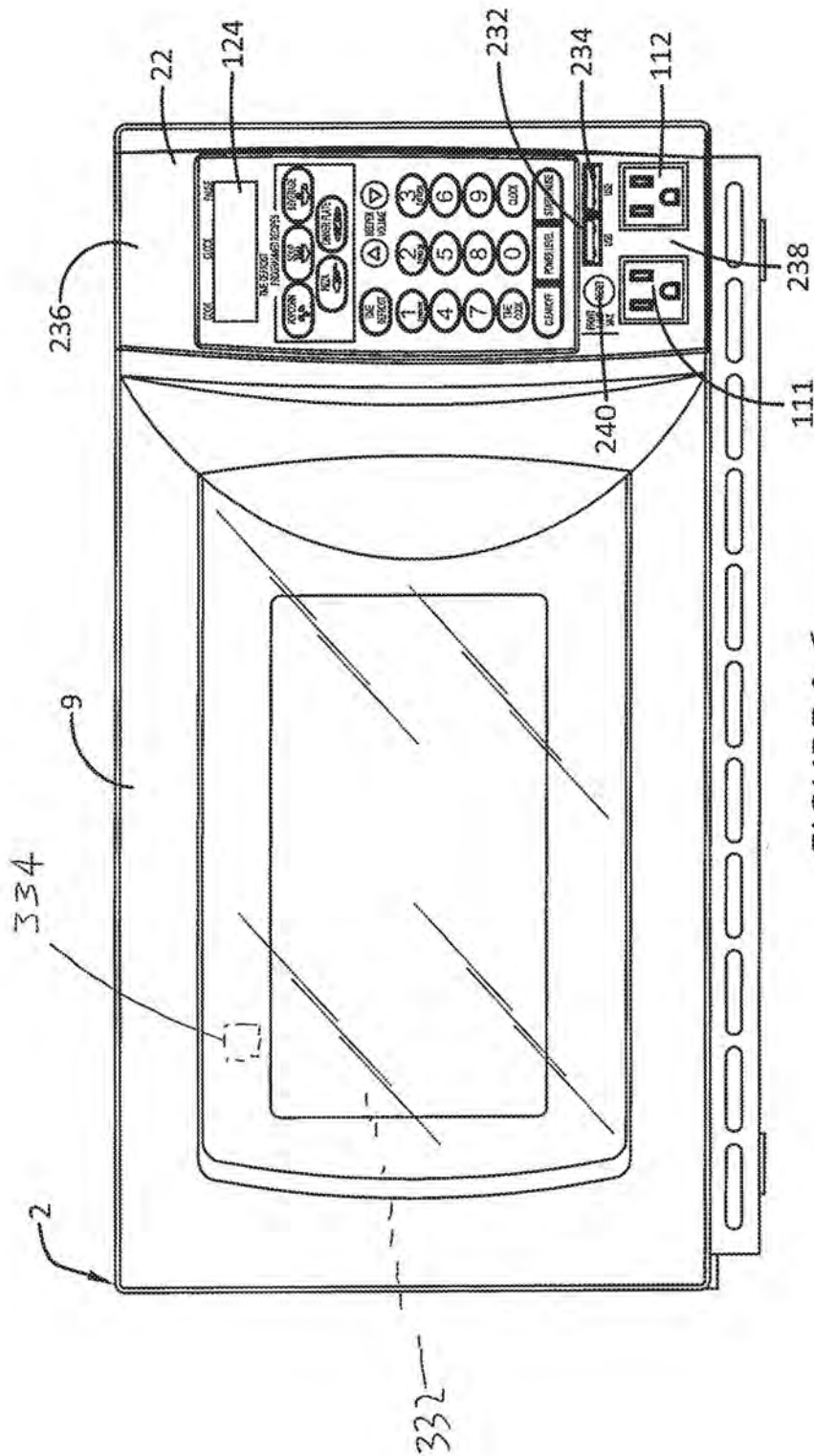
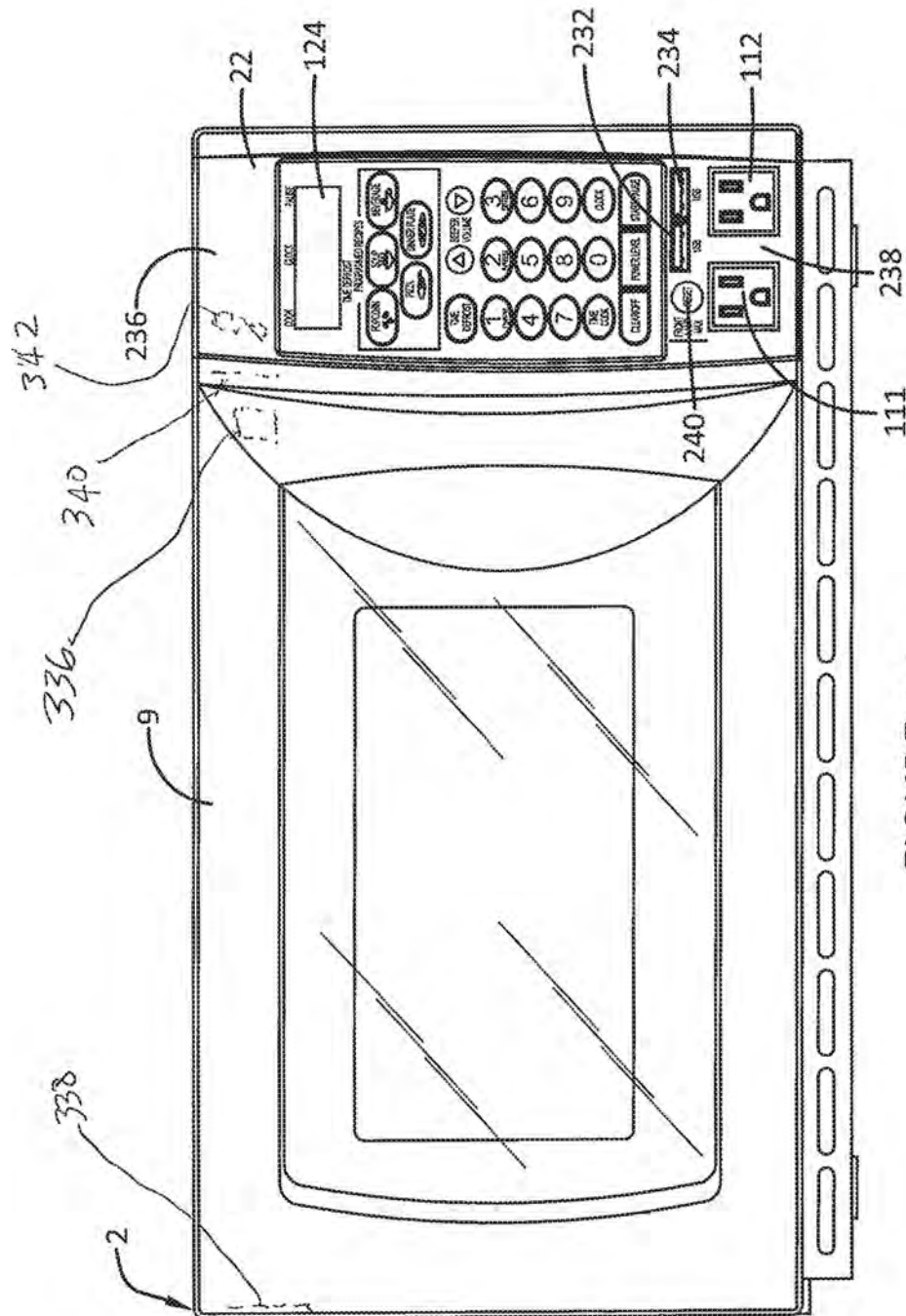


FIGURE 25



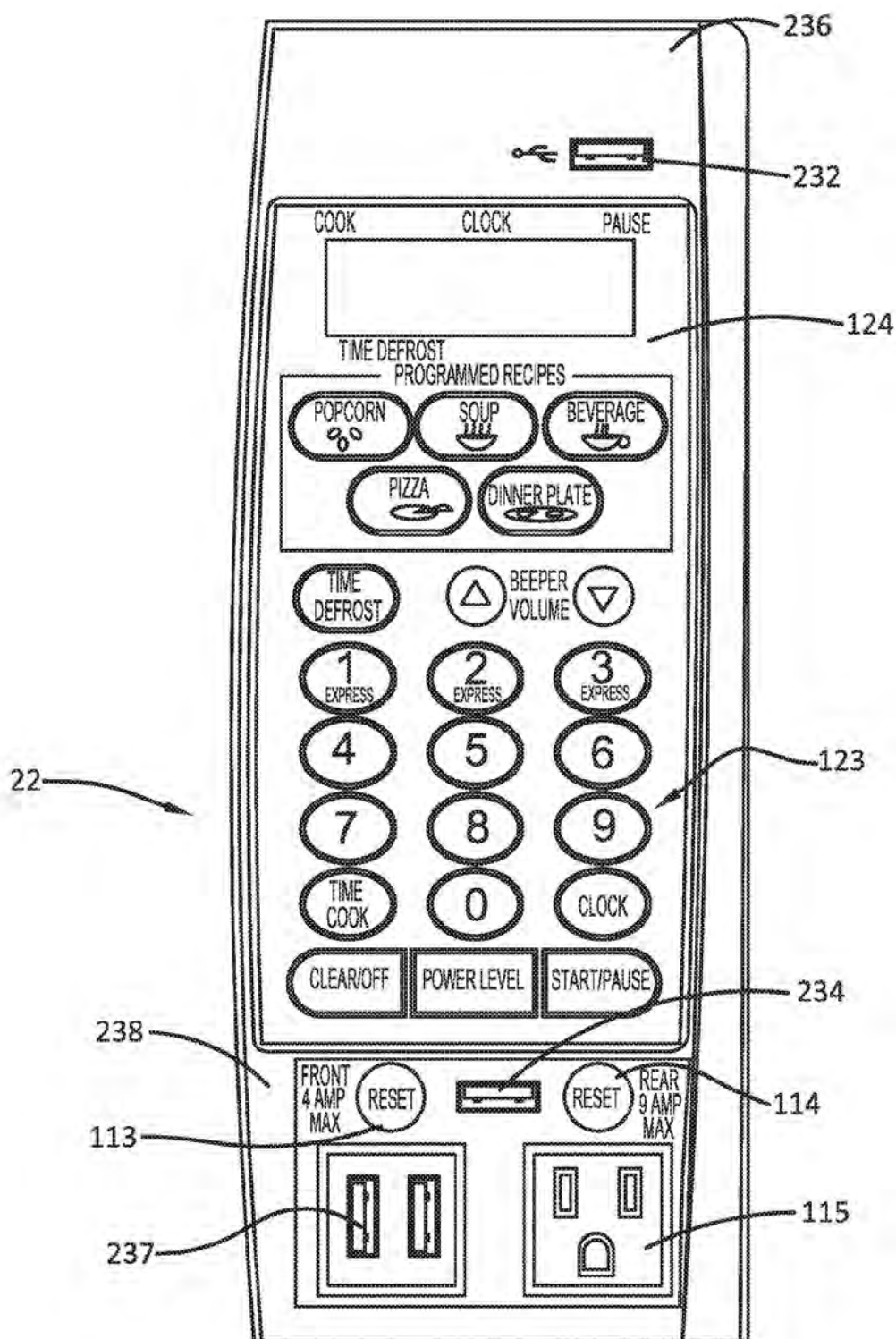


FIGURE 27

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MULTIPLE LINKED APPLIANCE WITH AUXILIARY OUTLET

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. application Ser. No. 14/262,290, filed on Apr. 25, 2014, which is a continuation-in-part of U.S. application Ser. No. 12/317,632 filed on Dec. 23, 2008, which claims benefit under 35 U.S.C. §119(e) of Provisional Application No. 61/009,419, filed Dec. 28, 2007, the disclosures of which are incorporated herein by reference in its entirety.

TECHNICAL FIELD

Exemplary embodiments relate to improvements to appliances. Specifically, exemplary embodiments relate to improvements to appliances that include compact refrigerator and microwave oven functionality.

BACKGROUND

Compact refrigerators are used for many different purposes. They are often found in dormitories, hotels, offices and other establishments. Compact refrigerators are also often used in housing units for storage of beverages in bar areas or entertainment areas. Compact refrigerators provide useful storage for refrigerated items without the requirement for the considerable floor space and power draw that is required for a full size refrigerator.

Compact refrigerators and associated appliances may benefit from improvements.

SUMMARY

In one exemplary embodiment, an apparatus is provided that includes a microwave oven. The microwave oven includes a radiation emitting microwave element and a microwave housing. The microwave housing bounds a cooking interior area. The radiation emitting microwave element is operative to irradiate the cooking interior area. The apparatus also includes a refrigerator. The refrigerator includes a refrigerator housing. The refrigerator housing bounds a cooled refrigerator interior area. The refrigerator housing is in fixed operative connection with the microwave housing. The refrigerator includes a refrigerant compressor, or other refrigeration technology. The refrigerant compressor is operative to compress a refrigerant material. The refrigerant material is operative to cause cooling of the cooled refrigerator interior area. The apparatus includes at least one power control circuit. The at least one power control circuit is operative to cause electrical power to be selectively delivered to the microwave element and the compressor. One of the microwave element and compressor does not operate when the other of the microwave element and the compressor operates. The microwave oven further includes at least one sensor emitter and at least one sensor receiver configured to receive radiation from the at least one sensor emitter, wherein air of at least a portion of the cooking interior area extends intermediate of the at least one sensor emitter and the at least one sensor receiver. The apparatus also includes at least one safety circuit. The at least one safety circuit is in operative connection with the at least one sensor emitter, the at least one sensor receiver, and the microwave element. The at least one safety circuit is operative to cause the at least one sensor emitter to emit

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sensor radiation and the at least one sensor receiver to sense sensor radiation from the at least one sensor emitter while the microwave element operates during a cooking session. A determination is made that a transmission amount of sensor radiation from the at least one sensor emitter that reaches the at least one sensor receiver has fallen by at least a threshold amount during the cooking session, due to smoke in the cooking interior area. Responsive at least in part to the determination, the microwave element is no longer supplied with electrical power.

BRIEF DESCRIPTION OF THE DRAWINGS

The system of the application is explained in more detail below with reference to the accompanying drawing, in which:

FIG. 1 is a front perspective view of an exemplary embodiment of an appliance system of this application.

FIG. 2 is a rear perspective view of the embodiment of FIG. 1 showing an alternative arrangement.

FIG. 3 is a block diagram of an embodiment of the system.

FIG. 4 is a schematic diagram of the embodiment of FIG. 3.

FIG. 5 is a logic flow diagram of an embodiment.

FIG. 6 is a logic flow diagram of another embodiment.

FIG. 7 is a logic flow diagram of another embodiment.

FIG. 8 is a graph illustrating the duty cycles of the appliances in the system of FIG. 3.

FIG. 9 is a block diagram of an alternate embodiment.

FIG. 10 is a schematic diagram of the embodiment of FIG. 9.

FIG. 11 is an illustration of a control panel of the embodiment of FIG. 9.

FIG. 12 is a front view of the microwave oven according to another embodiment.

FIG. 13 is a side view of the microwave oven door of FIG. 12.

FIG. 14 is a top perspective view of a charging pad on the top portion of a microwave oven.

FIG. 15 is an illustration of a control panel of an alternate embodiment.

FIG. 16 is a schematic diagram of the embodiment of FIG. 15.

FIG. 17 is a front view of the microwave oven according to another embodiment.

FIG. 18 is a schematic diagram of the embodiment of FIG. 17.

FIG. 19 is a front view of the microwave oven according to another embodiment.

FIG. 20 is a schematic diagram of the embodiment of FIG. 19.

FIG. 21 is a rear view of the microwave oven according to the embodiments of FIGS. 12-19.

FIG. 22 is a similar view as that of FIG. 21 except that the AC cord is shown.

FIG. 23 is a logic flow diagram of an embodiment.

FIG. 24 is a front view of the microwave oven according to another embodiment.

FIG. 25 is a front view of the microwave oven according to another embodiment.

FIG. 26 is a front view of the microwave oven according to another embodiment of this application.

FIG. 27 is an illustration of a control panel of an alternate embodiment.

DETAILED DESCRIPTION

A multiple linked appliance system 1, for example, a combination microwave oven 2 and refrigerator 3, incorporated

rating features of the present application is illustrated in the Figures. Although the present application will be described with reference to the embodiments shown in the drawings, it should be understood that embodiments may have many alternate forms. In addition, any suitable size, shape or type of elements or materials could be used. The computer or controller devices described in this application may be constructed having one or several processors and one or several program product modules stored in one or several memory elements. For illustration, computer or controller components may be described as individual units by function. It should be understood, that in some instances, these functional components may be combined.

In the exemplary embodiments, the circuits described therein may comprise one or more circuits including data processors which for purposes hereof corresponds to any electronic device that is configured via circuit executable instructions that can be implemented in either hardware circuits, software, firmware or applications that are operative to enable the circuits to process data and carry out the other actions described herein. For example, the circuits may include circuits that correspond to one or more or a combination of a CPU, FPGA, ASIC or any other integrated circuit or other type or circuit that is capable of processing data. The processors may be included in a computer, server or other type of electronic device. Further, the circuits described herein may include data stores that correspond to one or more of volatile or non-volatile memories such as random access memory, flash memory, magnetic memory, optical memory, solid state memory or other devices that are operative to store computer executable instructions and data. Computer executable instructions, may include instructions in any of a plurality of programming languages and formats including, without limitation, routines, subroutines, programs, threads of execution, objects, methodologies and functions which carry out the actions such as those described herein. Structures for the circuits may include, correspond to and utilize the principles described in the textbook entitled *Microprocessor Architecture, Programming, and Applications* with the 8085 by Ramesh S. Gaonker (Prentiss Hall, 2002), which is incorporated herein by reference in its entirety. Of course it should be understood that these circuit structures are exemplary and in other embodiments, other circuit structures for storing, processing, resolving and outputting information may be used.

In exemplary embodiments the refrigerator may be connected to a power supply that provides a connection for the microwave oven to be connected to the same supply. A single plug, therefore, may serve to connect both appliances and the current required for each appliance is supplied by the same supply cord and circuit. In exemplary embodiments power may be supplied by a 110V AC current outlet.

To make this combination attractive for use in dorm rooms, hotel rooms, recreational vehicles, tractor trailer cabs, and other similar locations, it may be necessary to provide some way by which the peak currents of both appliances are not demanded from the supply at the same time. Many household circuits are protected from overload conditions by an automatic circuit breaker that is activated when current in the circuit exceeds the breaker rating. This is 15 amps in many circuits.

The duty cycle of a refrigerator used in these combined systems includes a current spike that occurs during the first few seconds of operation. This is the start up current for the refrigerator compressor and is considerably reduced as the compressor attains its operational speed. In typical refrigerator appliances the peak current may be in the range of 7

to 9 amps, while the steady state current may level off at 1.4 amps or less. A microwave oven demands a relatively steady 8 to 13 amps of cooking power during operation of the cooking element. It is apparent that an overload condition will occur frequently, when both appliances are in use, unless some control is exercised.

In an exemplary embodiment, a combination microwave and refrigerator system is constructed having a single plug input supply. The microwave oven is adapted to provide power to a refrigerator through a power supply outlet, and to auxiliary receptacles adapted for connection to devices that operate at a low power draw. The microwave oven includes a microprocessor power control circuit or controller adapted to monitor operation of the refrigerator compressor and controls the power to the microwave magnetron cooking element and other components. The current draws on the low power receptacles are separately monitored for control by the microwave controller. The microwave controller is adapted to balance the duty cycles of the connected appliances attached to avoid overload conditions. A control logic flow is implemented internally within the microwave controller. A receptacle or other power connecting power supply outlet for the refrigerator and the low power auxiliary receptacle may be implemented as part of the microwave control panel.

In one embodiment, the auxiliary outlets are constructed to provide low power for the purpose of recharging cellular mobile phones, personal media devices and digital cameras, in addition to operating lap top computers and other low power devices. The current to the auxiliary outlets is sensed and provided to the microwave controller.

In another embodiment, the power to the auxiliary outlets is disabled by the microwave controller when the microwave magnetron is energized or whenever the current to the auxiliary outlets exceeds a preset value.

In one embodiment, a control model or logic flow is established and executed by the microwave controller. The model is dependent on the state of operation of the microwave magnetron. As part of the control model, the power being drawn to the compressor is monitored to sense operation of the compressor to compress refrigerant to provide cooling. When cooking power is demanded by the microwave the compressor is disabled by having electrical power thereto withdrawn by the control circuit for a preset minimum period. When microwave demand ceases, refrigerator compressor power is restored provided that the preset minimum period has expired.

In another embodiment of the control model, sensing circuits are connected to monitor current drawn to the auxiliary outlets. The control model is adapted to disable the power to the auxiliary receptacles, if the microwave commences cooking operation. In addition the auxiliary receptacles are disabled if a predetermined maximum current draw is sensed. Another control model is based on operation of the refrigerator and operates to disable the auxiliary receptacles when the compressor is in an operation condition, such as for example in the start up mode.

In one aspect of an exemplary embodiment, a non-transitory processor storage readable medium having processor executable program instructions embodied therein for operating at least one processor of a control circuit to control a system of multiple linked appliances having a microwave oven, a refrigerator, and an auxiliary power supply outlet is provided. The processor executable program code causes the control circuit to disable the refrigerator and the auxiliary power supply outlet, when the microwave demands power,

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and enable the auxiliary power supply outlet when the microwave is not drawing cooking power.

One embodiment of a multi-appliance interconnected system 1 is illustrated in FIG. 1. This embodiment consists of two appliances, a refrigerator 3 and a microwave oven 2. Refrigerator 3 is electrically connected to microwave oven 2 by power cord 7 to refrigerator receptacle 15, shown at the rear of the microwave 2 in FIG. 2. Refrigerator 3 is generally subject to control by the microwave microprocessor controller which is alternatively referred to as power control circuit 4 of the microwave oven 2. The power control circuit may be operative to cause electrical power to be selectively delivered to the microwave magnetron and the refrigerator compressor. A single cord 8 provides input electrical power to the system 1 from receptacle 5 through microwave 2. In the case where stand alone appliances are used, as shown in FIGS. 1 and 2, microwave oven 2 is connected directly to power source 5. The refrigerator 3, as the heaviest component, is used as the base with the microwave oven 2 stacked on top. In the selection of the refrigerator 3, it would be advantageous in one embodiment for the height of the refrigerator to be no more than 48 inches above the floor. This provides a more ergonomic operation of the microwave oven 2 for the user. In addition, in the stacked position of the appliances in an exemplary embodiment, the doors 9 and 10 of the microwave 2 and refrigerator 3, respectively, are arranged in a common plane.

At least one power control circuit 4 serves as a controller for the operation of the microwave oven 2 and is also adapted to control the other components of system 1, as shown in FIG. 3. Power is distributed throughout the system 1 under control of microwave controller 4 and digitally operated switches such as relays 19 and 20 of FIG. 3. Power is distributed to each of the appliances 2 and 3, and to auxiliary low power receptacles 11 and 12. In use lamps 13 and 14 in the form of LEDs or the like may be connected to the auxiliary receptacles to indicate power being available or disabled. The low power auxiliary receptacles 11 and 12 are provided to permit convenient access for plugging in a low power device, for example, rechargeable devices, such as cellular phones, PDAs, or other electronic devices that do not demand high power. As shown in the graph of FIG. 8, there are instances during which, if more than one of the appliances is in use, the cumulative current would cause an overload condition.

Control panel 22 of microwave oven 2 may be adapted to provide a display of the particular status of the controlling relays. For example, LEDs 13 and 14 may indicate that power to the outlets 11, and 12 are disabled or available. In one embodiment the lamps will light when power is available at the outlet and flash when disabled. In another embodiment the lamps will light when power is disabled at the outlet and not activate when power is available at the outlet as a means to reduce the Standby Power requirements. A button operated touch panel provides manual control.

As shown in FIG. 4, in order to control the power to the microwave 2, refrigerator 3 and receptacles 11 and 12, sensing circuits, may be coupled to the control circuit to monitor current to the appliances and the auxiliary receptacles. A relay 20 is connected in the power line to the refrigerator and may be actuated by signals from controller 4. In particular, according to an exemplary embodiment, sensing circuits 16, as shown in FIG. 4, have sensors 17 and 18 coupled to the power line of the auxiliary outlets 11 and 12 to monitor the current being used by a connected device. Sensors 17 and 18 may include current sensing transformers of the type available from Triad Magnetics of Corona, Calif.

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The signals generated by sensors 17 and 18 may be used to activate switches or other control components, such as relays 19. Relays 19 may be actuated by control circuit 4 to enable and disable power to the low power auxiliary outlets 11 and 12 in response to signals from sensors 17 and 18. A maximum current may be set by the power control circuit 4 to prevent overload of the outlets 11 and 12. In one embodiment of the system of this application, the maximum current limit is set at 2 amps.

In another embodiment, a clock function 21 included in the at least one control circuit 4 is used to provide timed delays during which, for example, refrigerator 3 would be prevented from undesirably rapid on/off cycles. When the compressor of the refrigerator 3 is disabled during microwave cooking operation, a time delay of 3 minutes is provided during which refrigerator 3 will remain disabled, even if microwave use is only for a short period. Control circuit 4 may be programmed to manage the power to the components of the system to avoid overload conditions, while minimizing disruptions in the use of an individual appliance. A model of operative events and related control operations may be designed into the program instructions executed by at least one control circuit 4 to provide a control methodology as illustrated in FIGS. 5-7.

In one embodiment, as illustrated in the block diagram of FIG. 3, at least one control circuit 4, constructed as part of the controller for microwave 2, is adapted to process the sensor signals and identify particular events in the system 1 related to a particular appliance. Circuit 4 controls the power to microwave 2 and refrigerator 3 and also low power receptacles 11 and 12 to avoid overload conditions. The circuit 4 could be programmed to execute the control methods illustrated and described below. In one embodiment, the circuit 4 includes a control microprocessor for microwave oven 2 and is adapted to execute the program instructions described below. Control circuit is coupled directly to refrigerator outlet 15 and low power outlets 11 and 12.

In one embodiment, shown in FIG. 1, the outlets 11, and 12, are installed as part of the front control panel of microwave oven 2. In FIG. 2, in another embodiment, the auxiliary receptacles 11 and 12 and refrigerator receptacle 15 are accessible at the rear of the microwave oven 2. In these alternative embodiments, the microwave oven 2 is connected by supply cord 8 directly to power supply receptacle 5. Refrigerator 3 is connected by power cord 7 to receptacle 15 in microwave oven 2 as shown in FIG. 2.

In one embodiment, control models comprising logic flows are established as shown in FIGS. 5-7 for execution by the at least one control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware within the circuit 4. The models shown are, in the first instance, dependent on the state of operation of microwave oven 2. The current demands of the microwave 2 when drawing cooking power are generally the most significant contribution to overload, as shown in FIG. 8. To avoid overload conditions, power to the low power receptacles 11 and 12 and refrigerator receptacle 15 is disabled during microwave operation. If the refrigerator 3 compressor is drawing power when the microwave 2 is turned on to commence cooking, the power to the refrigerator compressor is turned off and clock function 21 is used to determine a predetermined period during which the compressor of refrigerator 3 cannot be restarted. A time delay, for example, of 3 minutes, may be set through programming of the control circuit and when this delay period is expired, receptacle 15 may again be enabled.

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provided microwave cooking operation has ceased. This prevents a too rapid restart of the compressor that may otherwise result in damage.

In the embodiment shown in FIG. 5, if low power is demanded at receptacle 11 or 12 and microwave oven 2 is not in use for cooking, power is supplied to the low power receptacles, provided further, that the current demand at an individual outlet does not exceed a preset limit, for example, 2 amps. Since the auxiliary outlets may be enabled during refrigerator compressor operation, there may be an overload generated at peak compressor operation. In one embodiment the control circuitry acts to disable the auxiliary outlets during compressor startup to prevent accidental overload of the system. Therefore as illustrated in the logic flow diagram of FIG. 5, control circuitry may be adapted to check the operational status of the refrigerator, as well as the microwave oven, prior to enabling the auxiliary outlets.

FIGS. 9-11 illustrate another embodiment. In this embodiment the sensing components 117 and 118 are connected to reduce the risk of overload by the combined demands of the auxiliary outlets 111 and 112 and the refrigerator outlet 115. In the configuration as shown in FIG. 10, current sensor 117 is connected to monitor the current draw through the refrigerator outlet 115 and is configured to limit the refrigerator current component so that it does not exceed 10 amps. Current sensor 118 is connected to monitor the combined current in the auxiliary outlets 111 and 112. Current sensor 118 is constructed to limit the combined auxiliary outlet current to 4 amps. In this manner the risk of overload is minimized. In the block diagram of FIG. 9, the microwave 102 having at least one control circuit comprising controller 104 is connected to power supply 105. Clock function 121 of the controller provides a timing device to determine a restart delay for refrigerator 103. Sensing circuit/sensor 117 is connected to monitor the current demanded by refrigerator 103 and sensing circuit/sensor 118 is connected to low power receptacles 111 and 112 to monitor the combined current draw of receptacles 111 and 112.

In this embodiment, as shown in FIG. 11, a control panel 122 is arranged with a keypad 123 for manual control and a display 124. Auxiliary outlet 111 is shown as accessible from the front and is associated with a status LED indicator and reset button 113 that may be caused to be on during use and switch to a flashing mode when the microwave is drawing cooking power. Refrigerator outlet 115 is also shown to be accessible from the front panel and is associated with an LED indicator and reset button 114. Similarly LED indicator 114 is controlled to be on during use of the refrigerator and to switch to a flashing mode when the microwave is drawing cooking power. In another embodiment, the status LED indicator and reset button 113 may be caused to be off during use and switched on or to a flashing mode when the microwave is drawing cooking power. Similarly, in this embodiment, the LED indicator 114 is controlled to be off during operation of the refrigerator compressor and switched on or to a flashing mode when the microwave radiation cooking element is operating.

A further embodiment of the processor operational model is shown in FIG. 6. In this model, the refrigerator compressor draws or demands power. This may be triggered by a temperature rise of the refrigerator interior area within the housing of the refrigerator and involve start up of the refrigerator compressor with an associated peak power demand. If the microwave is currently drawing cooking power, the cycling of the refrigerator compressor will be delayed. If the microwave cooking element was on and subsequently cycled off, the clock function 21 is used to

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determine if the restart can occur. Under some circumstances, it may be necessary to give the refrigerator compressor priority to prevent an undesirable rise in temperature. In the latter instance, the control circuit can be coupled to the refrigerator temperature sensor to execute a time sequence during which the microwave cooking element will be disabled by not having power supplied thereto to allow the refrigerator to return to proper operating temperatures.

In the embodiment of FIG. 7, priority is given to the power demands of the microwave oven, as indicated above. Use of the receptacles 11, 12, and 15 are, therefore, disabled during microwave cooking operation. The operational models, illustrated in FIGS. 5-7, may be established by logic flows implemented by instructions that are programmed or imbedded in controller 4.

In this manner a system of linked appliances, including a microwave oven, refrigerator, and at least one low power appliance may all be connected through a common supply cord to a receptacle providing house current or other electrical power level without the risk of inconvenient interruptions during use caused by overloads.

It is also advantageous to provide such a combination microwave/refrigerator system that also provides auxiliary outlets for low power applications, such as for the purpose of recharging cellular phones, operating lap top computers and other low power devices, while controlling the operation of the appliances to avoid overload conditions.

In another exemplary embodiment as illustrated in FIGS. 12 and 13, the auxiliary outlets or receptacles 211, 212 may be included as part of the front control panel 222 of the microwave oven 202 and located on the upper portion 270 of the front control panel 222. The auxiliary outlets 211, 212, front control panel 222 and microwave oven 202 are similar to auxiliary outlets 11, 12, front control panel 22, and microwave oven 2 except for that discussed below. In this exemplary embodiment, the auxiliary outlets 211, 212 are positioned side by side with respect to each other with each of the auxiliary outlets 211, 212 being at the same height as the other. The auxiliary outlet 211 of FIG. 12 may be associated with a status LED indicator and reset button 213, which is located on the lower portion 272 of the front control panel and in vertical alignment with the auxiliary outlet 211. The status LED indicator and reset button 213 may be caused to be on during use and switched to a flashing mode when the microwave oven 202 is drawing cooking power. The auxiliary outlet 212 of FIG. 12 may be associated with status LED and reset button 214, which is located on the lower portion of the front control panel and in vertical alignment with the auxiliary outlet 212. The status LED indicator and reset button 214 may be caused to be on during use and switched to a flashing mode when the microwave oven 202 is drawing cooking power. In another embodiment, the status LED indicator and reset button 213 may be caused to be off during use and switched on or to a flashing mode when the microwave oven is running. Similarly, in this embodiment, the status LED indicator and reset button 214 may be caused to be off during use and switched on or to a flashing mode when the microwave oven is cooking. All other elements are similar in structure and function as that of the embodiments shown in FIGS. 1-11. Thus, the same reference numbers will be used in this exemplary embodiment to indicate elements that are similar in the embodiments shown in FIGS. 1-11.

Smart technology may be included in each of the exemplary embodiments. For example, a user may be able to regulate the refrigerator 3 such as by turning it on and off remotely by a remote control 215. The remote control 215

may include a hand held device such as a cellular phone. The cell phone may also be a smart phone. A charging pad 219 (FIG. 14) may be provided on the microwave oven 2 or other suitable place to receive the smart phone for charging the smart phone. For example, a wireless charging pad 219 may be positioned on top 225 of the microwave oven 2 for recharging the smart phone. The charging pad 219 may be built into the top 225 of the microwave oven 2 or be a separate piece that is mounted to the top 225 of the microwave oven 2. The exemplary charging pad 219 is an inductive charging pad and includes a recessed area 220 for receiving an item to be charged such as the smart phone. The control circuitry may include or be in operative connection with a wireless interface 221 configured for communicating with for the remote control 217 for controlling the microwave or refrigerator and work in conjunction with the control circuitry to perform functions such as removing the supply of electrical power to the microwave oven 2 and/or refrigerator 3. USB ports 223, 224 may be provided in the area of the charging pad 219. Alternatively, or in addition, power outlets may be provided in proximity to the charging pad 219. Alternatively, the charging pad 219 may be provided on the front, side, rear or bottom of the microwave oven 2.

As seen in FIGS. 16, 18, and 20, a safety sensor which is alternatively referred to herein as a safety circuit 226 such as a smoke or gas sensor may be provided in the microwave oven 2. The smoke sensor 226 operates to turn off the microwave oven upon sensing smoke or polluted air indicative of a potentially dangerous condition such as excessive smoke generated from overcooked food. The safety sensor 226 may be powered on or otherwise operational when the microwave oven is in operation. The sensor includes programmed instructions and may implement logic flows and algorithms to determine the optimal activation point. The exemplary smoke sensor may be battery-powered or powered by house current through the control circuitry with an optional battery backup when the power from the house current is out. The smoke sensor may include an ionization smoke sensor that uses a radioisotope, typically Americium-241, to ionize air. The ionization smoke sensor operates to turn off the cooking function of the microwave oven upon sensing a difference due to smoke indicative of a potentially dangerous condition. The smoke sensor may include a radiation type smoke detector that may contain a source of infrared, visible, or ultraviolet light emitter (typically an incandescent light bulb or light-emitting diode), a lens, and a photoelectric or other type of radiation sensing receiver (typically a photodiode).

The sensor 226 may include an alcohol sensor that is coupled with a thermistor 228. An exemplary alcohol sensor 226 may operate in a temperature range. When heating is sensed by the thermistor 228, the thermistor 228 through suitable control circuitry causes the alcohol sensor 226 to turn on and become operational and check for properties of the gas within the interior area of the microwave.

If the alcohol sensor 226 senses polluted air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor to the controller 104. Upon receiving the shutdown signal, the controller 104 determines that the radiation emitting element of the microwave oven 2 should be shut down and causes the microwave to shutdown through the withdrawal of electrical power. If (after the alcohol sensor is caused to be turned on by the thermistor) the alcohol sensor 226 senses air that is not indicative of a dangerous condition such as the air produced by normal

cooking of food in the microwave oven 2, the alcohol sensor circuitry will not send a shutdown signal to the controller 104.

Alternatively or in addition, a fault indicator 230 may be coupled to the microcontroller 104 or other circuitry to indicate that there is a dangerous condition upon detection by the alcohol sensor 226. For example, the fault indicator 230 may be a buzzer that is activated in response to the alcohol sensor 226 sensing polluted air indicative of a dangerous condition. In another example, fault indicator 230 may include the display 124 displaying a fault message such as "E-1" in response to the alcohol sensor 226 detecting polluted air indicative of a dangerous condition. Alternatively the fault indicator may output one or more signals, such as wireless alarm signals that can be detected by a receiver of an alarm system.

The exemplary embodiments may include a combination of fault indicators. For example, upon the alcohol sensor 226 sensing air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor 226 to the controller 104. Upon receiving the shutdown signal, the controller 104 determines that the microwave oven 2 should be shut down and causes the radiation element of microwave oven 2 to be shutdown by withdrawing electrical power therefrom. In addition in an exemplary embodiment, a buzzer is activated and the display 124 displays a fault message such as "E-1" in response to the alcohol sensor 226 sensing polluted air indicative of a dangerous condition.

The alcohol sensor 226 may be reset automatically responsive to the alcohol sensor 226 no longer detecting gas indicative of the dangerous condition. Alternatively or in addition, the alcohol sensor 226 may be reset upon a sensor sensing opening of the door 9 of the microwave oven 2. The display may display a "bar" or other suitable icon to indicate that the alcohol sensor 226 is turned on. Other types of suitable safety sensors may also be used instead of the alcohol sensor to detect a dangerous condition within the cooking area of the microwave.

In addition to a sensor which reacts to the gases generated from cooked food, the sensor 226 may use a temperature sensing capability such as, for example, using the thermistor 228 and related elements mentioned above.

Referring to FIG. 24, in another exemplary embodiment, the safety sensor which is alternatively referred to as a safety circuit may comprise an infrared sensor 326. The infrared sensor 326 may include two disposed infrared sensor elements in the form of a sensor emitter 328 and sensor receiver 330 (schematically shown in FIG. 24) provided on the microwave oven and located in the microwave's cavity 332. The exemplary infrared sensor 326 operates as follows. The sensor emitter 328 emits radiation and the sensor receiver 330 senses sensor radiation from the sensor emitter 328 while the microwave element operates during a cooking session. When smoke that is indicative of a dangerous condition passes in between the infrared sensor elements 328, 330, a determination is made by the safety circuit that a transmission amount of sensor radiation from the sensor emitter reaching the sensor receiver has fallen by at least a programmed threshold amount during the cooking session, due to smoke in the cooking interior area. Responsive to the determination, the cooking element of the microwave oven, is caused by the safety circuit to be no longer supplied with electrical power. The exemplary safety circuit may use the smoke point of oil or similar food products as the basis for its threshold amount, so that normal smoke emitted during the cooking or heating of food or beverages will not cause the infrared sensor 326 to deactivate cooking operation. The

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exemplary infrared sensor 326 would not require interaction from the microwave user. The exemplary safety sensor may be operative to cause an initial transmissivity level of sensor radiation that reaches the sensor receiver from the sensor emitter early in the cooking session to be stored in a memory associated with the safety circuit. The determination of a level of smoke corresponding to a dangerous condition is made in this embodiment responsive to the transmission amount of sensor radiation reaching the sensor receiver dropping by the threshold amount from the initial transmissivity level during the cooking session.

Referring to FIG. 25, in another exemplary embodiment, the safety sensor or safety circuit may comprise a light sensor 334, which detects the increase smoke density within the microwave's cooking area which is alternatively referred to as a cavity. The light sensor 334 may also include a sensor emitter and sensor receiver. The light sensor 334 may be provided in the microwave cavity 332 and may operate as follows. At the beginning of a cooking cycle, all of the light generated travels through the clean air to the light sensor 334. As smoke increases in density, the amount of light that travels to the sensor receiver is reduced. The circuitry of light sensor 334 includes a programmed trip point or threshold that corresponds to the reduced amount of light sensed caused by the amount of smoke, that is indicative of a dangerous condition. When the trip point is reached, the safety circuit causes the electrical power to the radiation emitting element to be turned off. A determination would be made based on the amount of smoke that corresponds to the trip point and its corresponding light sensor reading.

Referring to FIG. 26, in another exemplary embodiment, the safety sensor may include an optical motion sensor 336. The optical motion sensor 336 may also include a sensor emitter and sensor receiver. The optical motion sensor 336 may be positioned in the microwave cavity 332 at air exhaust vents 338, 340 of the microwave. The optical motion sensor 336 detects motion which is sensed due to the presence of smoke blown by an exhaust fan 342 of the microwave oven 2. The exhaust fan 342 is operative to cause air to move in an air passage connected to the microwave cavity. The sensor emitter and sensor receiver are operative to sense the transmission of radiation between the emitter and the receiver in the air passage. The optical motion sensor 336 has a trip point or threshold that corresponds to the presence of smoke of a predetermined density that corresponds to a reduced level of transmission that is indicative of a dangerous condition. When the trip point is reached, the optical motion sensor causes the cooking element of the microwave oven to be turned off. It should be noted that the exemplary optical motion sensor would not be positioned within the microwave cavity and directed toward a turntable therein, since the turntable itself may result in false alarms in some configurations.

Multiple sensors supported by control circuitry and associated algorithms may be used to determine the optimal point for removing electrical power from a microwave cooking element using sensed parameters that may include for example humidity, temperature rise and gas generated including combinations of absolute and relative values to analyze varied conditions. Other types of sensors may include flame sensors. Safety circuitry comprising flame sensors may detect and respond to the presence of a flame or fire. Upon the flame sensor detecting the presence of a flame, the flame sensor causes the cooking element of the microwave oven to turn off. The flame sensor may take the form of an optical flame sensor. The flame sensor may be of the type that utilizes ionization current flame detection. Alternatively,

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the flame sensor may be of the type that utilizes thermocouple flame detection.

Alternatively or in addition, the fault indicator 230 may be coupled to the controller 104 or other circuitry to indicate that there is a dangerous condition upon detection by any of the infrared sensor 326, light sensor 334, optical motion sensor 336, or flame or fire sensor in the embodiments described above. For example, the fault indicator 230 may be a buzzer that is activated in response to the safety sensor 226 sensing polluted air indicative of a dangerous condition. In another example, fault indicator 230 may include the display 124 displaying a fault message such as "E-1" in response to the safety sensor 226 detecting polluted air indicative of a dangerous condition.

Exemplary embodiments may include a combination of fault indicators. For example, upon the trip point or threshold value being reached by any of the infrared sensor 326, light sensor 334, or optical motion sensor 336, a shutdown signal is outputted by the sensor 226 to the controller 104. Upon receiving the shutdown signal, the controller 104 determines that the cooking element of the microwave oven 2 should be shut down and causes the microwave oven 2 to shutdown. In addition, a buzzer is activated and the display 124 displays a fault message such as "E-1" in response to the sensor 226 sensing polluted air indicative of a dangerous condition.

The smoke sensor, infrared sensor 326, light sensor 334, or optical motion sensor 336, may be reset automatically upon the sensor not detecting gas or other parameter indicative of the dangerous condition. Alternatively or in addition, the sensor may be reset upon circuitry sensing opening of the microwave door 9 of the microwave oven 2. The display may display a "bar" or other suitable icon to indicate that the sensor is turned on. Numerous types of suitable safety sensors may also be used instead of the alcohol sensor to detect a dangerous condition.

As shown in FIGS. 15, 16 and 27, the front control panel 22 of the microwave oven 2 may include Universal Serial Bus (USB) ports 232, 234 for connection, communication, and power supply between the front control panel 22 and electronic devices such as a personal computer, cell phone, Ipad®, Ipad®, or other suitable device to allow communication and/or charging of the electronic device plugged into the USB ports. In one exemplary embodiment, a first USB port 232 may be provided on the upper portion 236 of the front control panel 22, and a second USB port 234 may be provided on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112 and between the reset buttons 113, 114 as seen in FIG. 15. The first USB port 232 may be operatively connected to a three ampere fuse and a linear time-variant system (LVT) of 100 mA, 120 volts, and 12 watts. The second USB port 234 may be operatively connected to a linear time-variant system (LVT) of 200 mA, 120 volts, and 24 watts. The second USB port 234 may also be reset. The current sensor 118 may be constructed to limit the second USB port and the two auxiliary outlets to 12 amps. The USB ports 232, 234 may be in operative connection with respective printed circuit boards. Alternatively, as represented in FIG. 27, instead of auxiliary outlet 111, another USB port 237 may be provided on the front panel 22 at the location of the auxiliary outlet 111. Alternatively or in addition, one or more USB ports may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively or in addition, one or more auxiliary outlets may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven.

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oven. Alternatively, the refrigerator outlet may be provided on the top, bottom, or one of the sides of the microwave oven.

FIGS. 17 and 18 show another exemplary arrangement of the USB ports 232, 234. In this arrangement, the first and second USB ports 232, 234 are located side by side on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112. The USB ports 232, 234 are also located rightwardly (as viewed in FIG. 17) adjacent a status LED indicator and reset button 240. In this exemplary arrangement, current sensor 218 is connected to monitor the combined current in the USB ports 232, 234 and the auxiliary outlets 111 and 112. The current sensor 218 is constructed to limit the combined current in the USB ports and auxiliary outlets 111 and 112 to 12 amperes. The LED indicator and reset button 240 may illuminate when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and flash when disabled. In another embodiment, the LED indicator and reset button 240 may be off when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables the auxiliary outlets 111, 112 and the USB ports 232, 234 so that power may be supplied to them when the combined current in them falls from above to below the limit.

FIGS. 19 and 20 show an alternative arrangement in which one USB port 234 is located above the auxiliary outlets 111, 112 and rightwardly adjacent the status LED indicator and reset button 240. In this exemplary arrangement, the current sensor 218 is connected to monitor the combined current in the USB port 234 and auxiliary outlets 111 and 112. The current sensor 218 is constructed to limit the combined current in the USB port 234 and auxiliary outlets 111 and 112 to 12 amperes. Alternatively, the current sensor 218 may be constructed to limit the combined current in the USB port 234 and the auxiliary outlets 111 and 112 to 13 amperes. The LED indicator and reset button 240 may illuminate when power to the auxiliary outlets 111, 112 and the USB port 234 is available and flash when disabled. In another embodiment, the LED indicator and reset button 240 may be off when power to the auxiliary outlets 111, 112 and the USB port 234 is available and illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables the auxiliary outlets 111, 112 and the USB port 234 so that power may be supplied to them when the combined current in them falls from above to below the limit. Other elements of the embodiments of FIGS. 17-20 may be similar in structure and function as the embodiment shown in FIGS. 1-11. Thus, the same reference numbers may be used to indicate elements that are similar to those in the embodiments shown in FIGS. 1-11.

FIG. 21 shows the rear portion 244 of the microwave oven for the embodiments shown in FIGS. 12-20. Refrigerator outlet 15 is shown to be provided on and accessible from the rear portion 244 of the microwave oven and is associated with the LED indicator and reset button 214, which is also provided on the rear portion 244 of the microwave oven. FIG. 22 is a similar view as FIG. 21 except that AC cord 8 for the microwave oven is shown.

In the embodiments shown in FIGS. 12-22, logic flow control models may be established for execution by the controller which is also referred to as at least one control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware within the control

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circuit 104. The models or scenarios are, in the first instance, dependent on the state of operation of the microwave oven 2. The current demands of the microwave oven 2 are generally the most significant contribution to overload. To avoid overload conditions, power to the low power receptacles or auxiliary outlets, refrigerator receptacle, and/or USB ports is disabled during microwave operation.

FIG. 23 shows a flow chart illustrating several control models or scenarios. The control circuit 104 begins by determining whether the microwave oven is turned on or operating to perform cooling in step 246. When the microwave oven is turned on and operating to perform cooking, the rear refrigerator outlet 15, the two auxiliary outlets 111, 112 on the front control panel 22, and the two USB ports 232, 234 on the front control panel are all turned off or disabled, so that the total draw of current for the combination microwave and refrigerator is not over 15 amperes as indicated in step 248.

When the microwave oven is not drawing cooking power and items are plugged into the two USB ports 232, 234, two auxiliary outlets 111, 112, and rear refrigerator outlet 15, then the control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 2 amperes (approximately the average amperes when the refrigerator compressor is running) in step 250. If the refrigerator outlet 15 is drawing less than 2 amperes, then all the outlets 15, 111, 112 and USB ports 232, 234 are caused to be enabled, so that power may be supplied through them as indicated in step 252. If the refrigerator outlet 15 not drawing less than 2 amperes, the control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 254. If the refrigerator outlet 15 is drawing less than 14 amperes but not less than or greater than or equal to 2 amperes, then the auxiliary outlets 111, 112 and USB ports 232, 234 are disabled or turned off so that no power may be supplied to them as indicated in step 256. The refrigerator outlet 15 remains enabled. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 is disabled in step 258. This may be accomplished by tripping the relay 20 of the reset circuit off. In addition, the red LED light on the LED indicator and reset button 214 is turned on to identify the disabled condition of the refrigerator. Then, in step 260, the auxiliary outlets 111, 112 and USB ports 232, 234 are enabled so that power may be supplied through them.

Then, the control circuit determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 262. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 remains disabled and the red LED light on the LED indicator and reset button 214 remains turned on to identify the disabled condition of the refrigerator 3. This condition may occur, for example, if an electrical heater is plugged into the refrigerator outlet 15. When the refrigerator outlet 15 draws less than 14 amperes resulting from the overload condition being eliminated, the refrigerator outlet 15 will be enabled by the control circuit so that power may be supplied to the refrigerator outlet 15 upon the LED indicator and reset button 214 being depressed as indicated in step 264. Depression of the LED indicator and reset button 214 in this condition will also turn off the red LED light. The process then ends. It should be noted that the at least one control circuit 104 can make the determination in steps at the same time or in a different order.

Although exemplary embodiments are described herein as used in conjunction with vapor compression refrigerators,

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embodiments employing the principles described herein may also be used with other types of refrigerators. Such refrigerators may include refrigerators that use thermoelectric cooling, such as Peltier elements to provide cooling. Other embodiments may include absorption refrigerators to provide cooling. In such embodiments the components of the refrigerator apparatus which draw electrical power, are controlled through operation of at least one control circuit, to prevent, suspend or defer the operation thereof at times when the microwave radiation emitting element of other components that draw electrical power are to be operated, so as to avoid exceeding a maximum threshold for current draw for the combined appliance that is permitted by the at least one control circuit.

It should be understood that the above description is only illustrative of the exemplary embodiments. Various alternatives and modifications can be devised by those skilled in the art without departing from the exemplary embodiments. Accordingly, the present application is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

What is claimed is:

1. Apparatus comprising:

a microwave oven,

wherein the microwave oven includes:

a radiation emitting microwave element,

a microwave housing, wherein the microwave housing bounds a cooking interior area, wherein the radiation emitting microwave element is operative to irradiate the cooking interior area,

at least one power control circuit, wherein the at least one power control circuit is operative to cause electrical power to be selectively delivered to the microwave element,

wherein the microwave oven further includes at least one sensor emitter and at least one sensor receiver configured to receive radiation from the at least one sensor emitter, wherein air of at least a portion of the cooking interior area extends intermediate of the at least one sensor emitter and the at least one sensor receiver, at least one sensor circuit, wherein the at least one sensor circuit is in operative connection with the at least one sensor emitter, the at least one sensor receiver, and the microwave element,

wherein the at least one sensor circuit is operative to cause the at least one sensor emitter to emit sensor radiation and the at least one sensor receiver to sense sensor radiation from the at least one sensor emitter while the microwave element operates during a current cooking session,

data to be stored in a memory associated with the at least one sensor circuit corresponding to an initial transmissivity level of transmitted radiation from the at least one sensor emitter that reaches the at least one sensor receiver early in the current cooking session,

comparison of a current level of transmitted radiation during the current cooking session and the initial transmissivity level,

a determination based on the stored data that the current level of transmitted radiation from the at least one sensor emitter that reaches the at least one sensor receiver has fallen by at least a threshold amount from the initial transmissivity level during the current cooking session, due to smoke in the cooking interior area,

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responsive at least in part to the determination, the microwave element to no longer be supplied with electrical power to prematurely end the current cooking session,

wherein the at least one sensor circuit is configured to reset after the premature end of the current cooking session responsive to the at least one sensor circuit, so that the at least one sensor circuit is operative to cause the radiation emitting microwave element to be allowed to be supplied with electrical power during a next subsequent cooking session.

2. The apparatus according to claim 1

wherein the microwave oven housing includes a fan, and at least one air passage,

wherein the at least one air passage is in connection with the cooking interior area,

wherein the fan is operative to cause air to move in at least one air passage,

wherein the at least one sensor emitter and the at least one sensor receiver are operative to sense the transmission amount in the at least one air passage.

3. The apparatus according to claim 1 further including a power supply outlet, wherein the power supply outlet is provided on the microwave oven,

wherein the power supply outlet is configured to receive an electrical connection to an appliance having lower power requirements than power requirements of the microwave oven,

wherein the at least one power control circuit is operative to cause electrical power to be selectively delivered to the microwave element, and the power supply outlet, wherein the power supply outlet does not operate when the microwave element operates.

4. The apparatus according to claim 1 and further comprising:

a power supply outlet provided on the microwave oven, wherein the power supply outlet is in operative connection with the at least one power control circuit,

a refrigerator configured to be connected to the power supply outlet,

wherein the refrigerator includes a refrigerator housing, wherein the refrigerator housing bounds a cooled refrigerator interior area, wherein the refrigerator housing is in fixed operative connection with the microwave housing, wherein the refrigerator includes a refrigerant compressor, wherein the refrigerant compressor is operative to compress refrigerant material, wherein the refrigerant is operative to cause cooling of the cooled refrigerator interior area,

wherein the at least one power control circuit is configured to:

disable refrigerator operation by not supplying electrical power to the compressor thereof, when the microwave element draws cooking power;

enable refrigerator operation by supplying electrical power to the compressor when the microwave element does not draw cooking power.

5. The apparatus according to claim 4, and further including a remote control, wherein the remote control is configured to control at least one operation of the refrigerator or the microwave oven, or an operation of each of the refrigerator and the microwave oven.

6. The apparatus according to claim 5, wherein the remote control comprises a mobile phone.

7. The apparatus according to claim 4, and further comprising at least one Universal Serial Bus (USB) port,

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wherein the at least one USB port is positioned on at least one of the refrigerator and the microwave oven.

8. The apparatus according to claim 4 and further including a temperature sensor in the cooking interior area, wherein the temperature sensor is in operative connection with the at least one sensor, and wherein the at least one power control circuit is operative to cause the microwave element to no longer be supplied with cooking power to prematurely end the current cooking session responsive to the determination and the temperature being sensed above a temperature level during the current cooking session.

9. An apparatus comprising:

a microwave oven configured to be connected to a source of electrical power and having a control circuit, wherein the control circuit is configured to control operation of the microwave oven;

a smoke sensor, wherein the smoke sensor is positioned in the microwave oven, and is in operative connection with the control circuit, wherein the smoke sensor is configured to cause cooking power to the microwave oven to be withdrawn prior to a set end time of a current cooking session upon the smoke sensor sensing smoke indicative of a dangerous condition; and

wherein the smoke sensor is configured to be reset after ending the current cooking session prior to the set end time based on sensing the smoke indicative of the dangerous condition, to enable the microwave oven to deliver cooking power in a next subsequent cooking session responsive at least in part to the smoke sensor no longer sensing the smoke indicative of the dangerous condition.

10. The apparatus according to claim 9 and further comprising:

a power supply outlet on the microwave oven, wherein the power supply outlet is in operative connection with the control circuit,

a refrigerator, wherein the refrigerator is electrically connected with the power supply outlet,

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wherein the control circuit is operative to withdraw electrical power from the refrigerator when the microwave oven draws cooking power, deliver electrical power to the refrigerator when the microwave oven does not draw cooking power.

11. Apparatus comprising:

a microwave oven configured to be connected to a source of electrical power and having a control circuit configured to control operation of the microwave oven, wherein the microwave oven includes an interior area, a smoke sensor, wherein the smoke sensor is positioned in the interior area, wherein the smoke sensor is in operative connection with the control circuit, wherein the smoke sensor is configured to cause cooking power to be withdrawn from the microwave oven prior to a set end time of a current cooking session responsive at least in part to the smoke sensor sensing at least one change in an amount of smoke sensed by the smoke sensor which at least one change corresponds to a dangerous condition, and

wherein the control circuit is configured to reset after ending the current cooking session prior to the set end time due to sensing the dangerous condition, to enable cooking power to again be available to the microwave oven in a next subsequent cooking session responsive at least in part to the smoke sensor no longer sensing the dangerous condition.

12. The apparatus according to claim 11 and further comprising:

a power supply outlet on the microwave oven, a refrigerator configured to be connected to the source of electrical power by connection to the power supply outlet, wherein the refrigerator includes a compressor, wherein the control circuit is operative to cause electrical power to be unavailable to the compressor, when the microwave oven demands cooking power, electrical power to be available to the compressor when the microwave oven does not demand cooking power.

* * * * *

EXHIBIT
US Patent No. 11,27 , 76



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(12) **United States Patent**
Hall et al.

(10) **Patent No.:** **US 11,274,876 B2**
(45) **Date of Patent:** **Mar. 15, 2022**

(54) **MULTIPLE LINKED APPLIANCE WITH
AUXILIARY OUTLET**

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Dennis O'Brien, Guelph (CA)

(73) Assignee: **Intirion Corporation**, Walpole, MA
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(Continued)

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H05B 6/66 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **F25D 23/12** (2013.01); **F25D 29/005**
(2013.01); **H05B 6/666** (2013.01); **H05B 6/68**
(2013.01)

(58) **Field of Classification Search**

CPC . H05B 6/68; H05B 6/808; H05B 6/66; H05B
6/645; H05B 6/666; F25D 23/12; F25B
29/00

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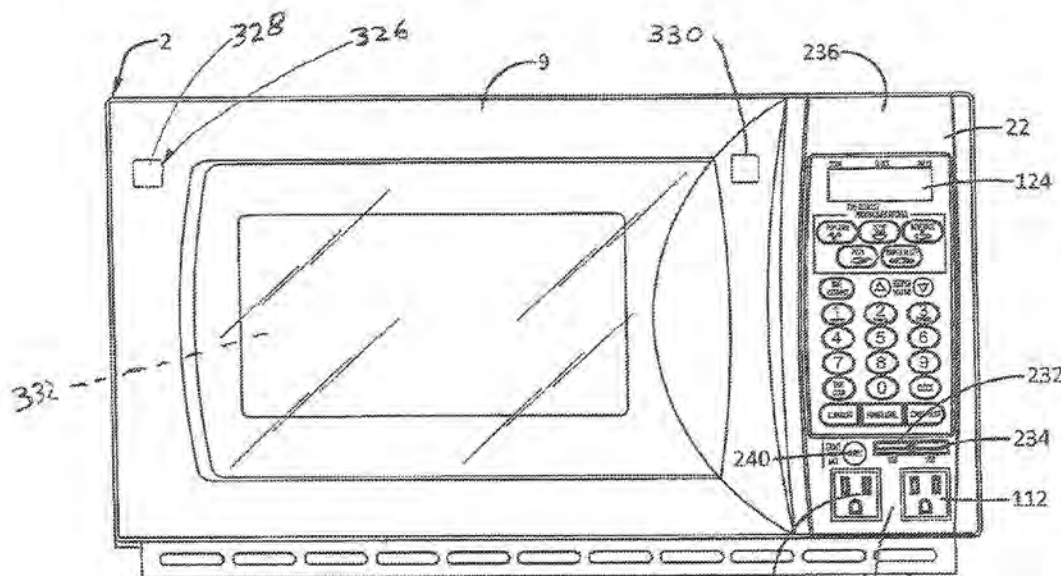
Primary Examiner — Hung D Nguyen

(74) *Attorney, Agent, or Firm* — Ralph E. Jocke; Walker
& Jocke

(57) **ABSTRACT**

A combination microwave and refrigerator system is provided. The microwave oven is connected to a source of power and has a control circuit for controlling the operation of the microwave oven. A first power supply outlet is provided on the microwave oven. A refrigerator is connected to the source of power by connection to the first power supply outlet. The control circuit is configured to disable the cooling operation of the refrigerator, when the microwave oven demands cooking power, and enable the cooling operation of the refrigerator when the microwave oven is not drawing cooking power. A safety sensor is provided in the microwave oven, and is configured to cause cooking power to the microwave oven to be turned off upon the safety sensor sensing a dangerous condition.

28 Claims, 25 Drawing Sheets



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Related U.S. Application Data

which is a continuation of application No. 15/135,883, filed on Apr. 22, 2016, now Pat. No. 9,664,436, which is a continuation-in-part of application No. 14/262,290, filed on Apr. 25, 2014, now Pat. No. 9,657,974, which is a continuation-in-part of application No. 12/317,632, filed on Dec. 23, 2008, now Pat. No. 8,742,304, application No. 16/671,383, which is a continuation-in-part of application No. 15/239,378, filed on Aug. 17, 2016, now abandoned.

- (60) Provisional application No. 61/009,419, filed on Dec. 28, 2007, provisional application No. 62/211,765, filed on Aug. 29, 2015, provisional application No. 62/262,954, filed on Dec. 4, 2015.

(51) **Int. Cl.**

H05B 6/68 (2006.01)
F25D 23/12 (2006.01)
F25D 29/00 (2006.01)

(58) **Field of Classification Search**

USPC 219/482, 483, 485, 488, 678, 679, 695,
 219/697, 702, 715, 716, 717, 718, 719,
 219/720, 721, 722, 723, 756, 761

See application file for complete search history.

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					109/24

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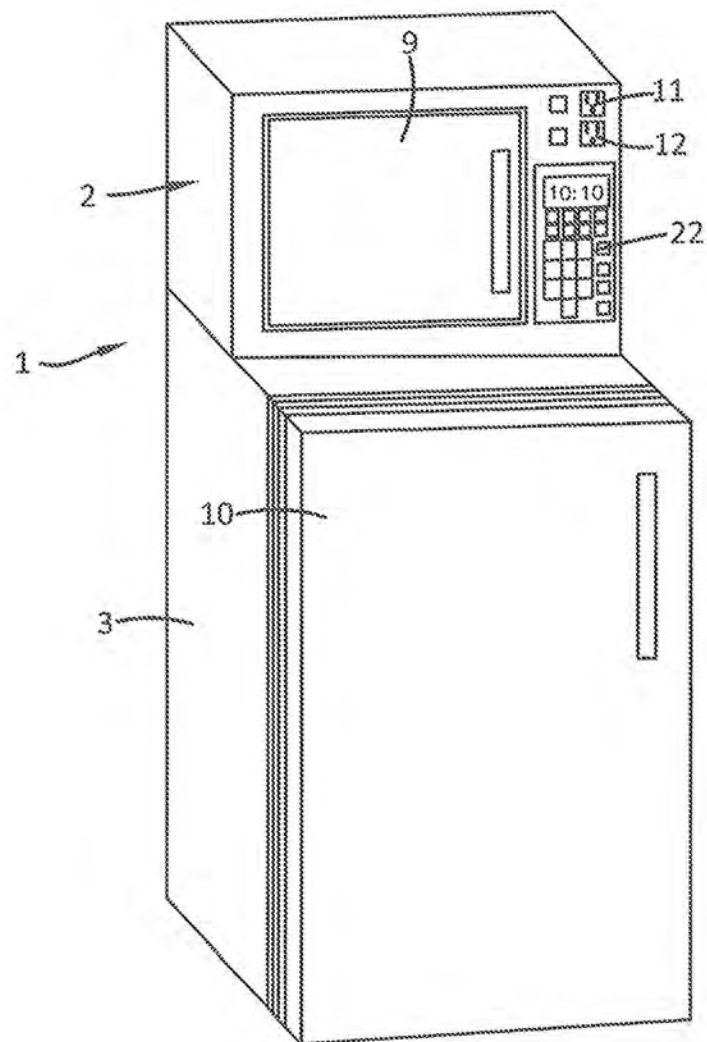


FIGURE 1

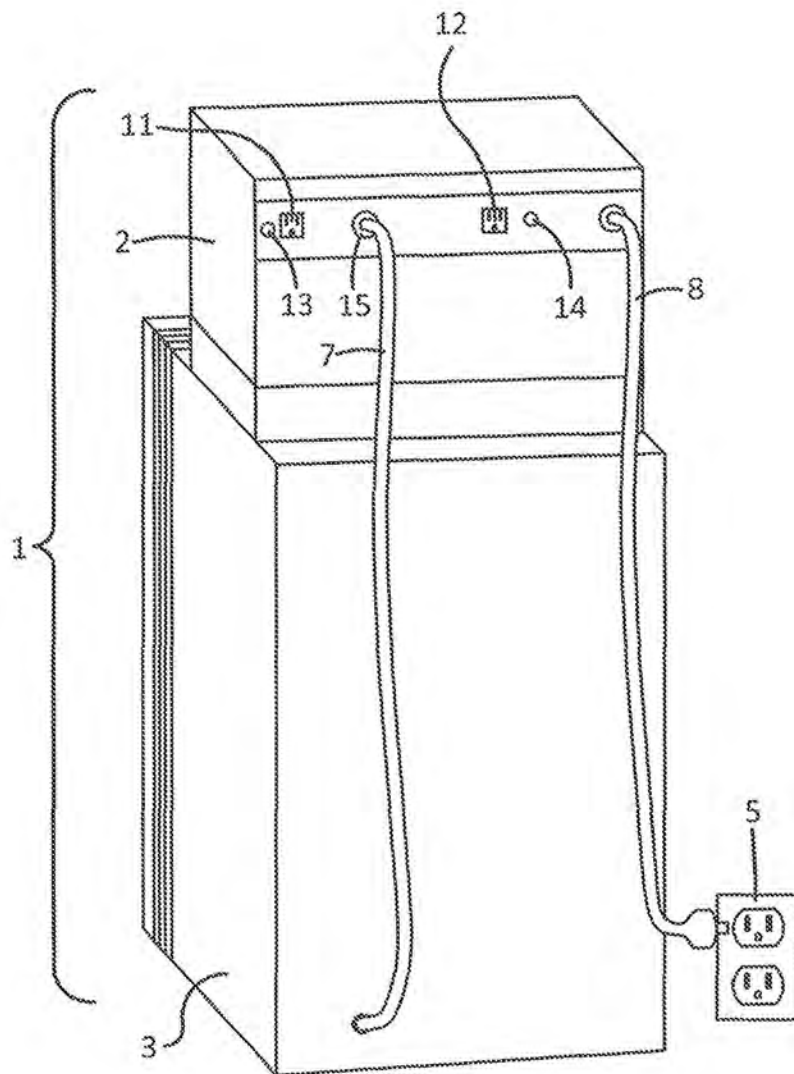


FIGURE 2

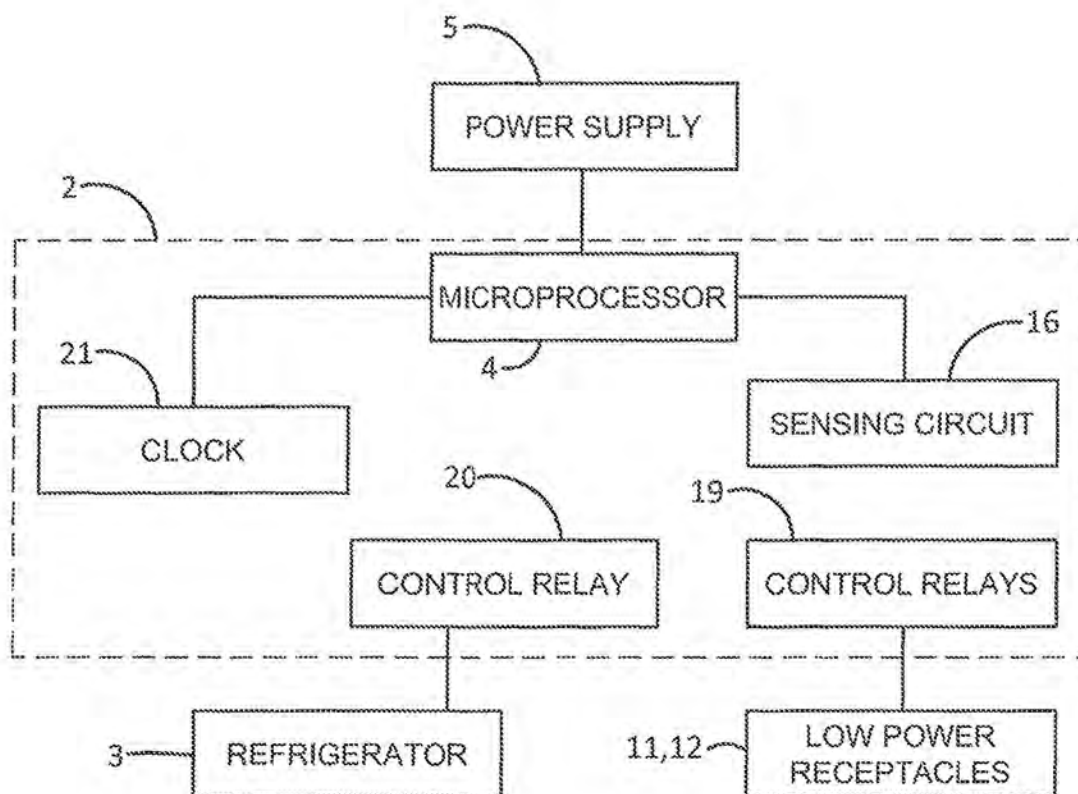


FIGURE 3

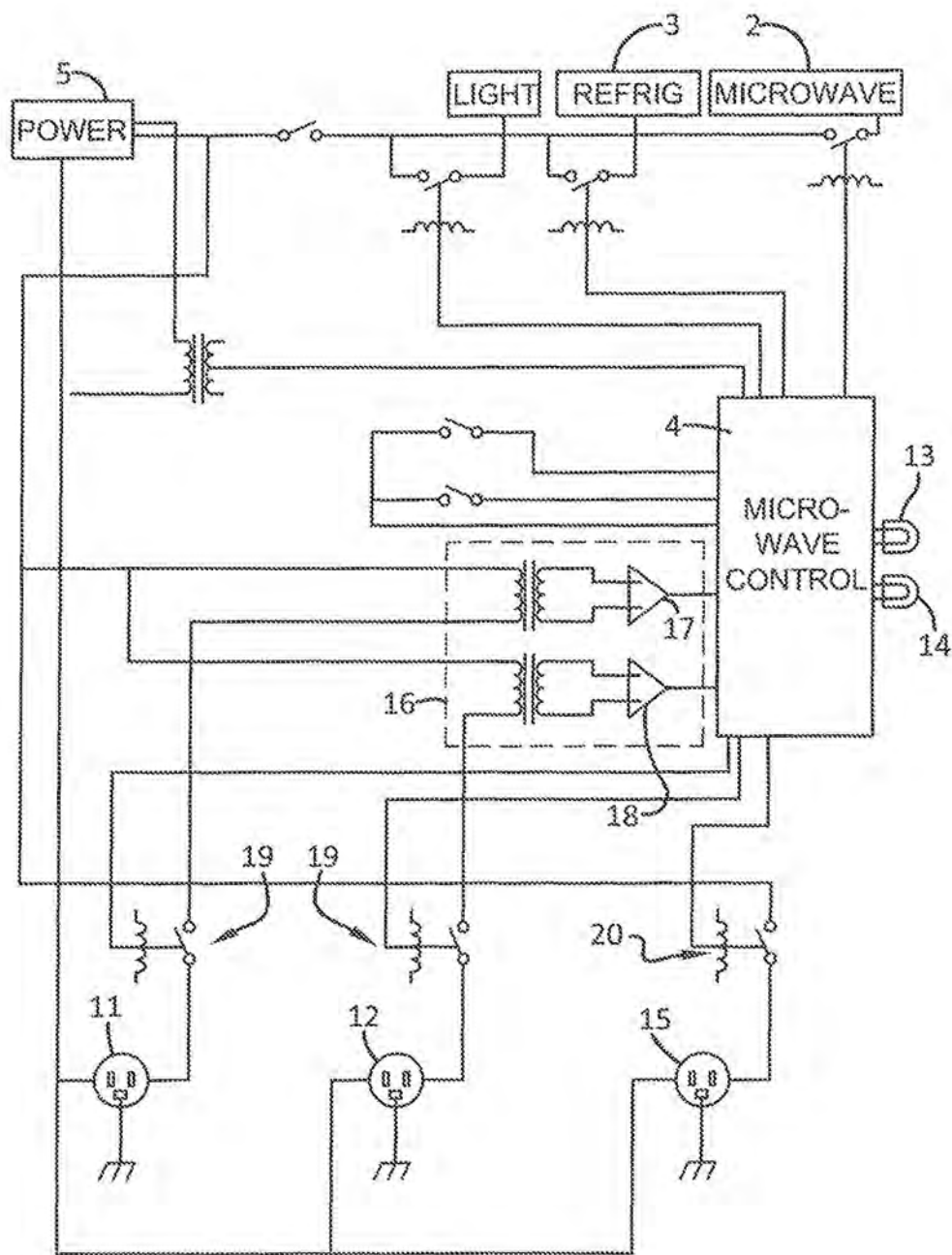


FIGURE 4

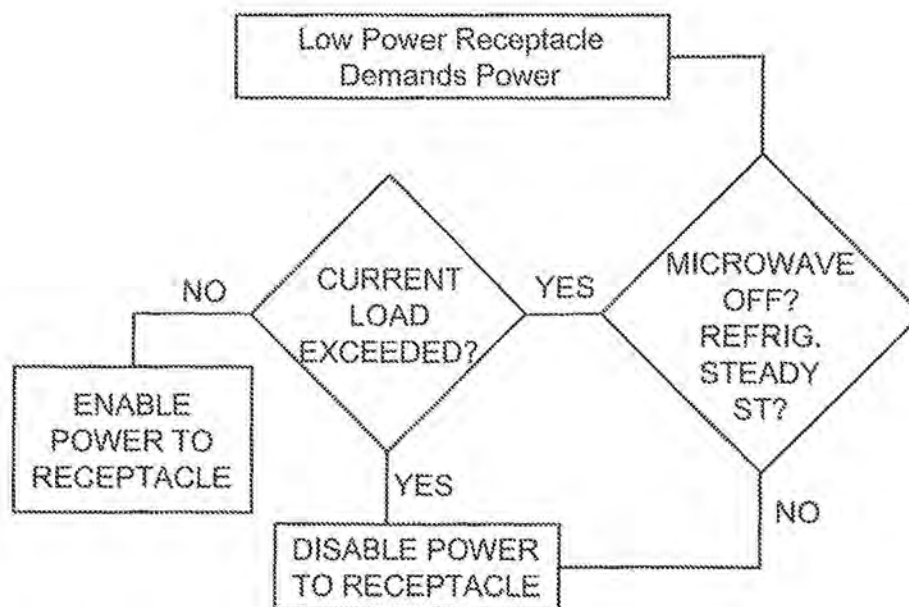


FIGURE 5

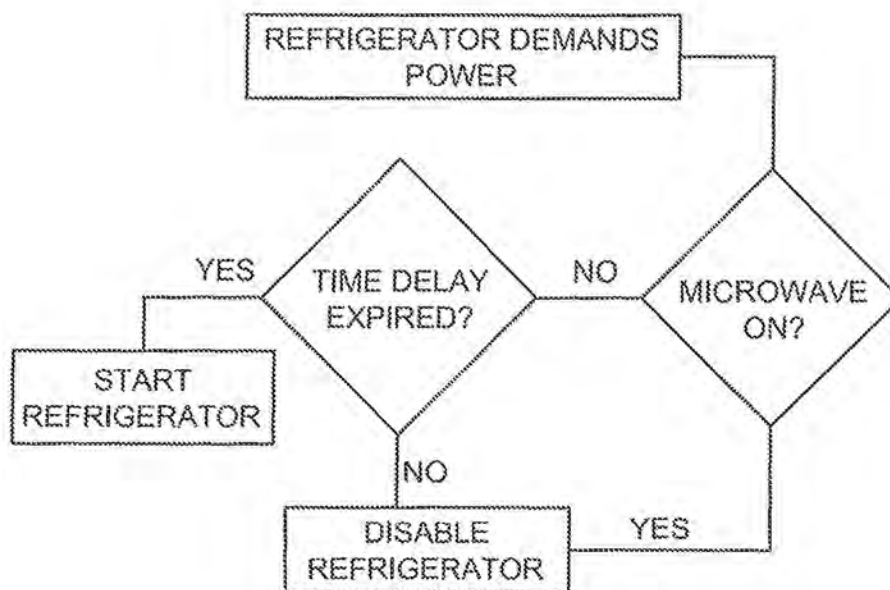


FIGURE 6

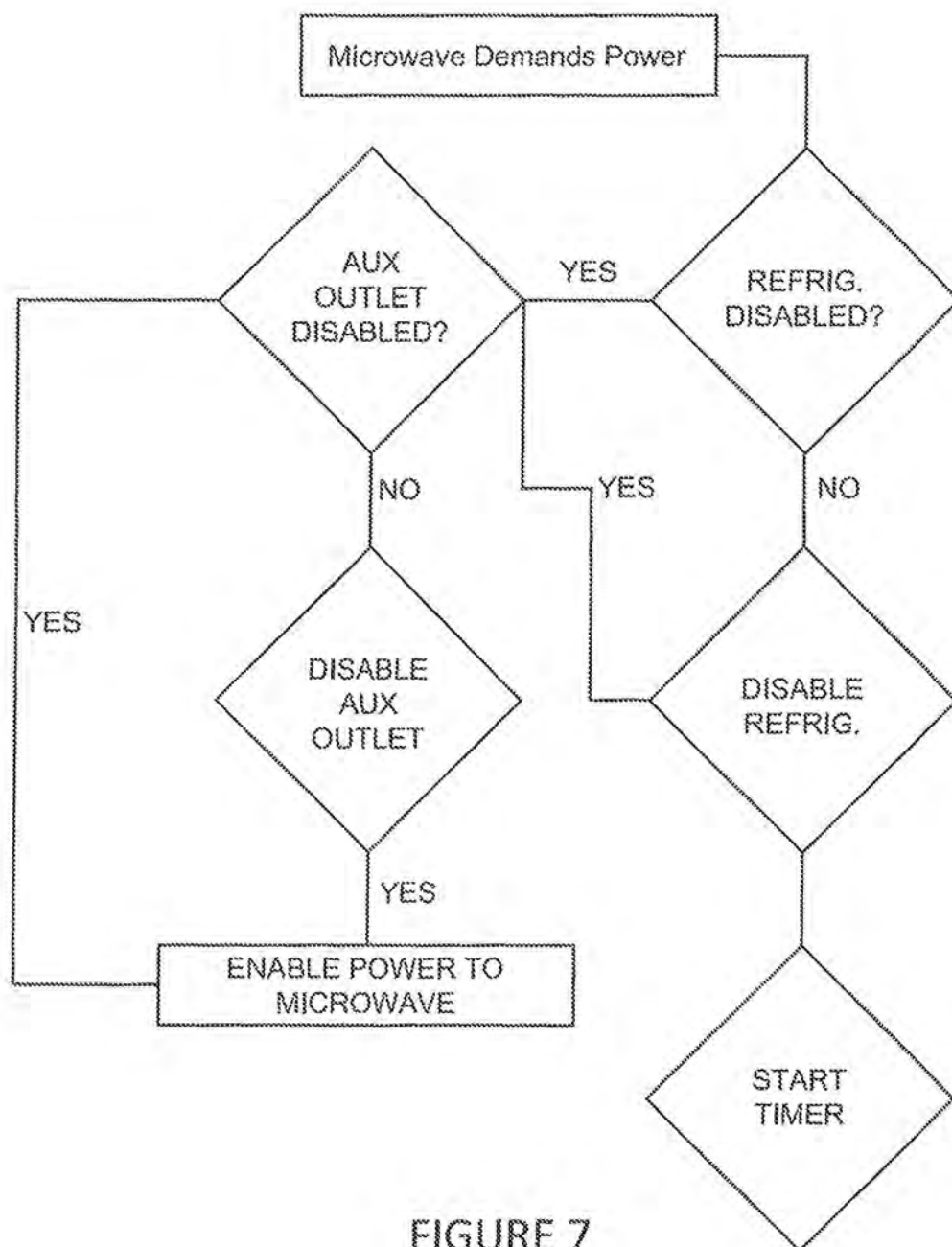


FIGURE 7

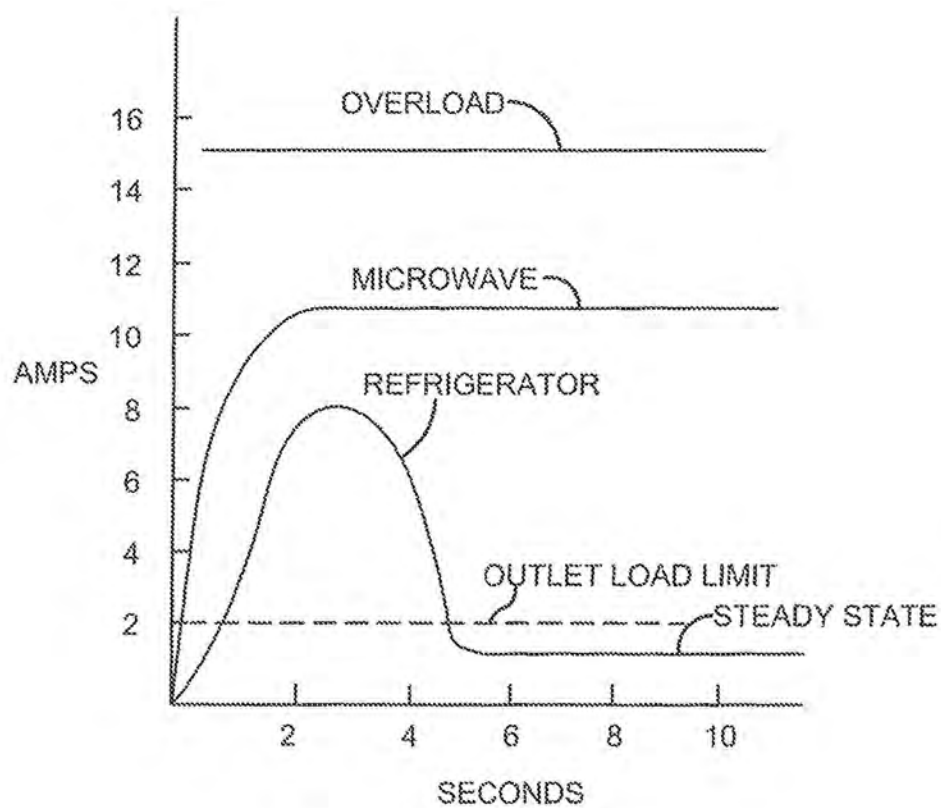


FIGURE 8

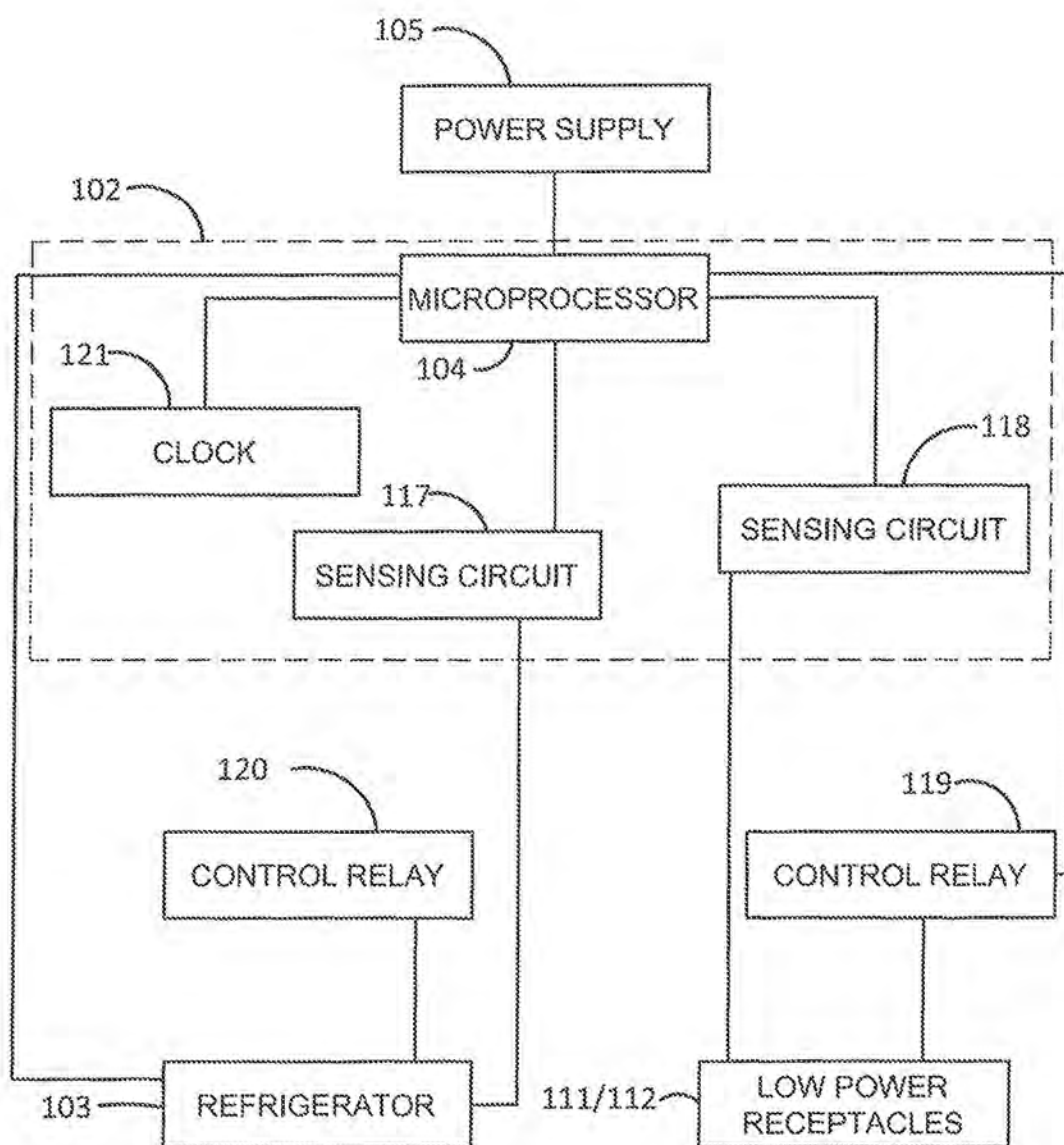


FIGURE 9

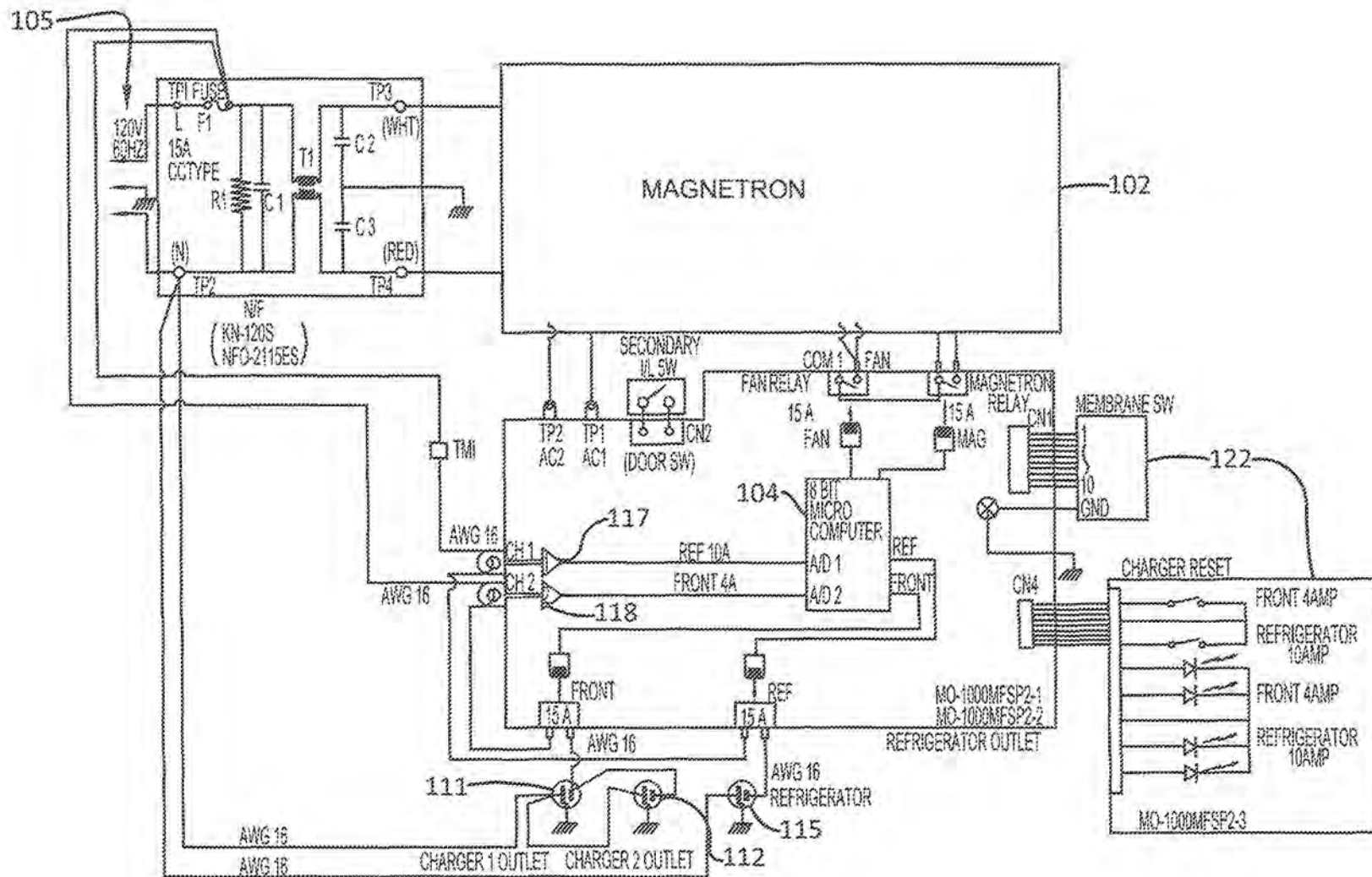
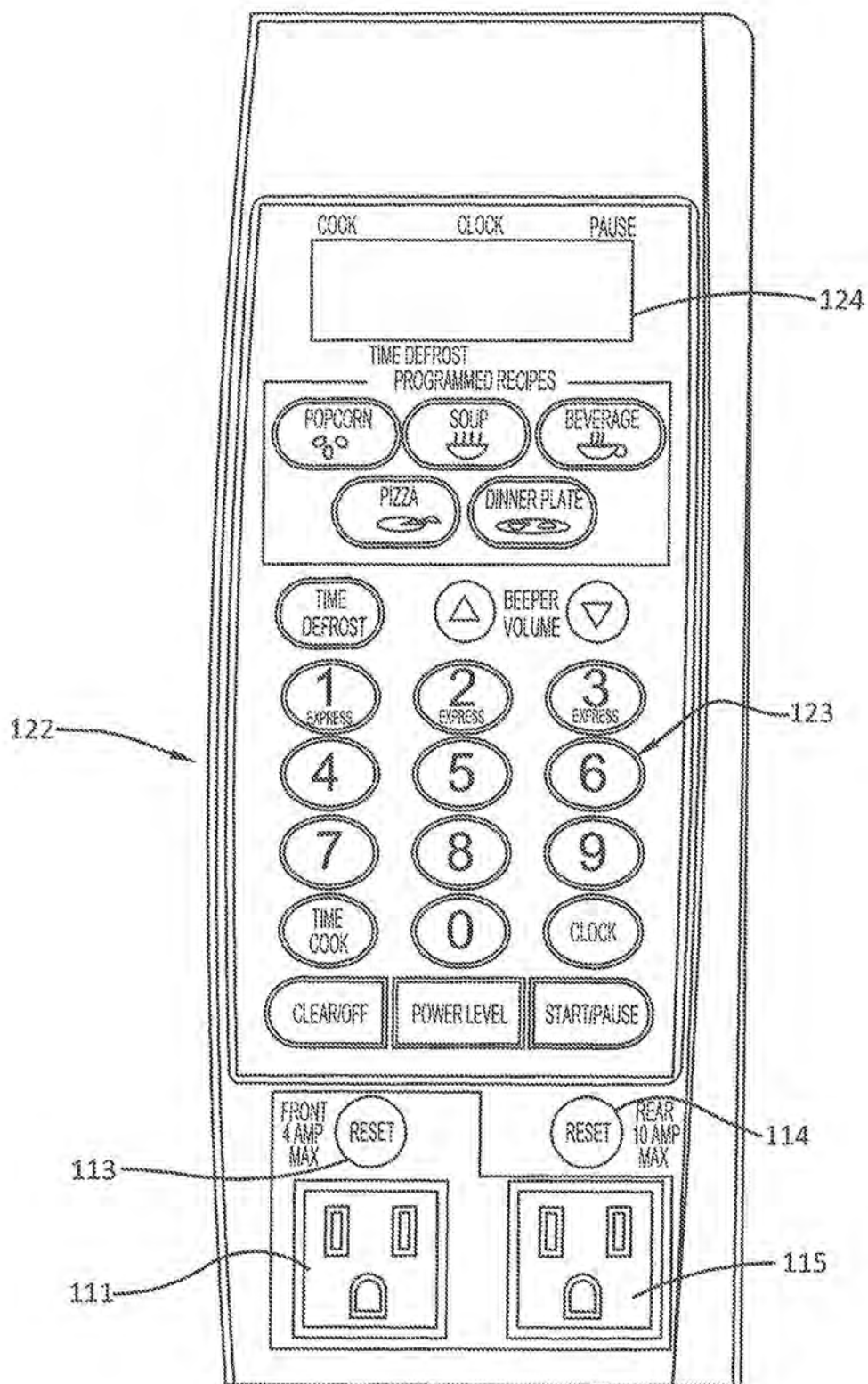
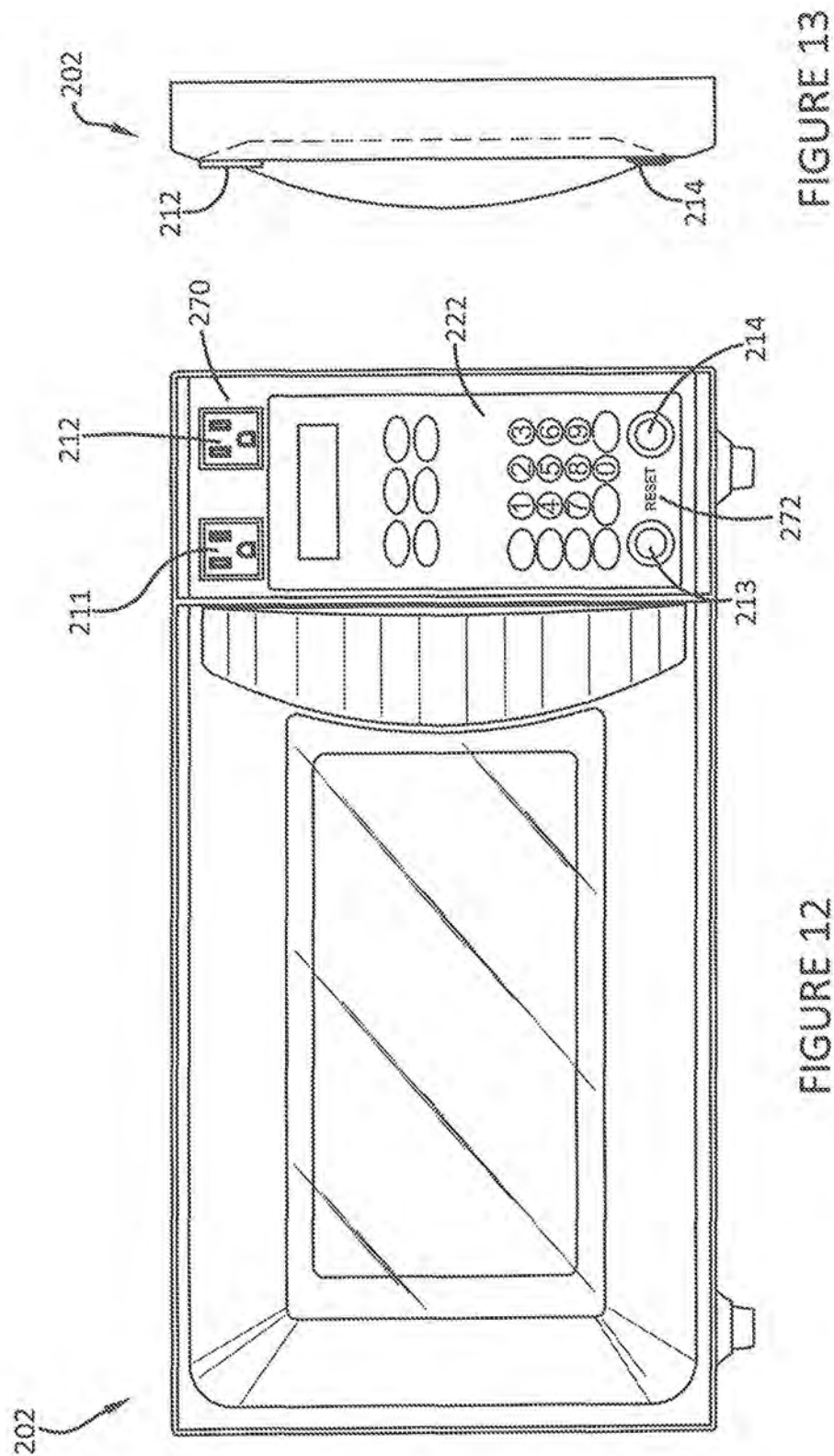


FIGURE 10





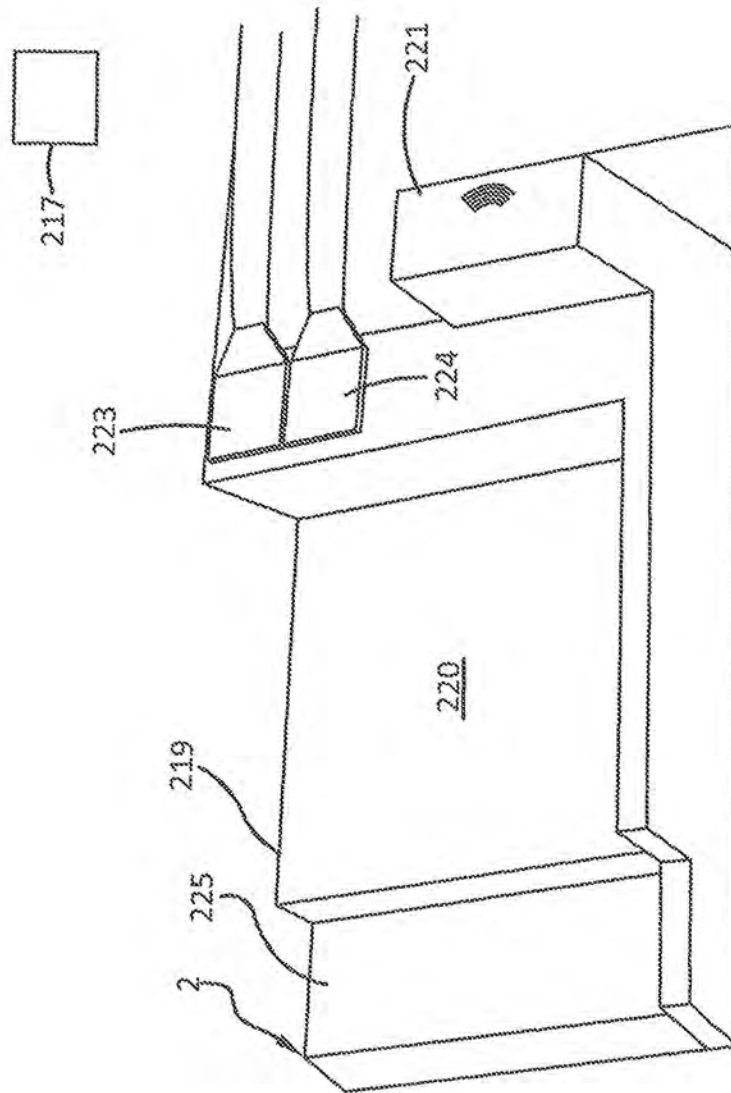


FIGURE 14

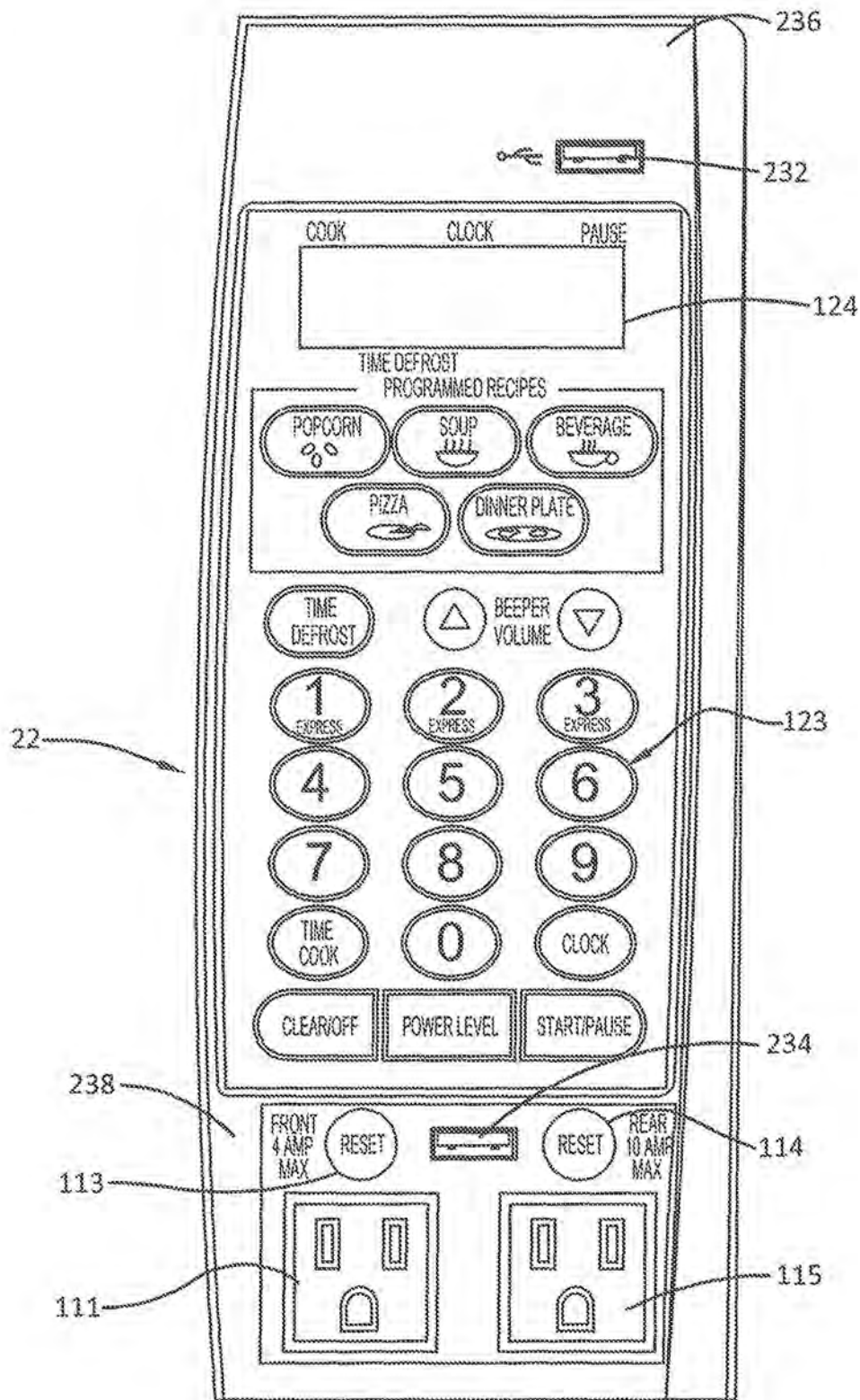


FIGURE 15

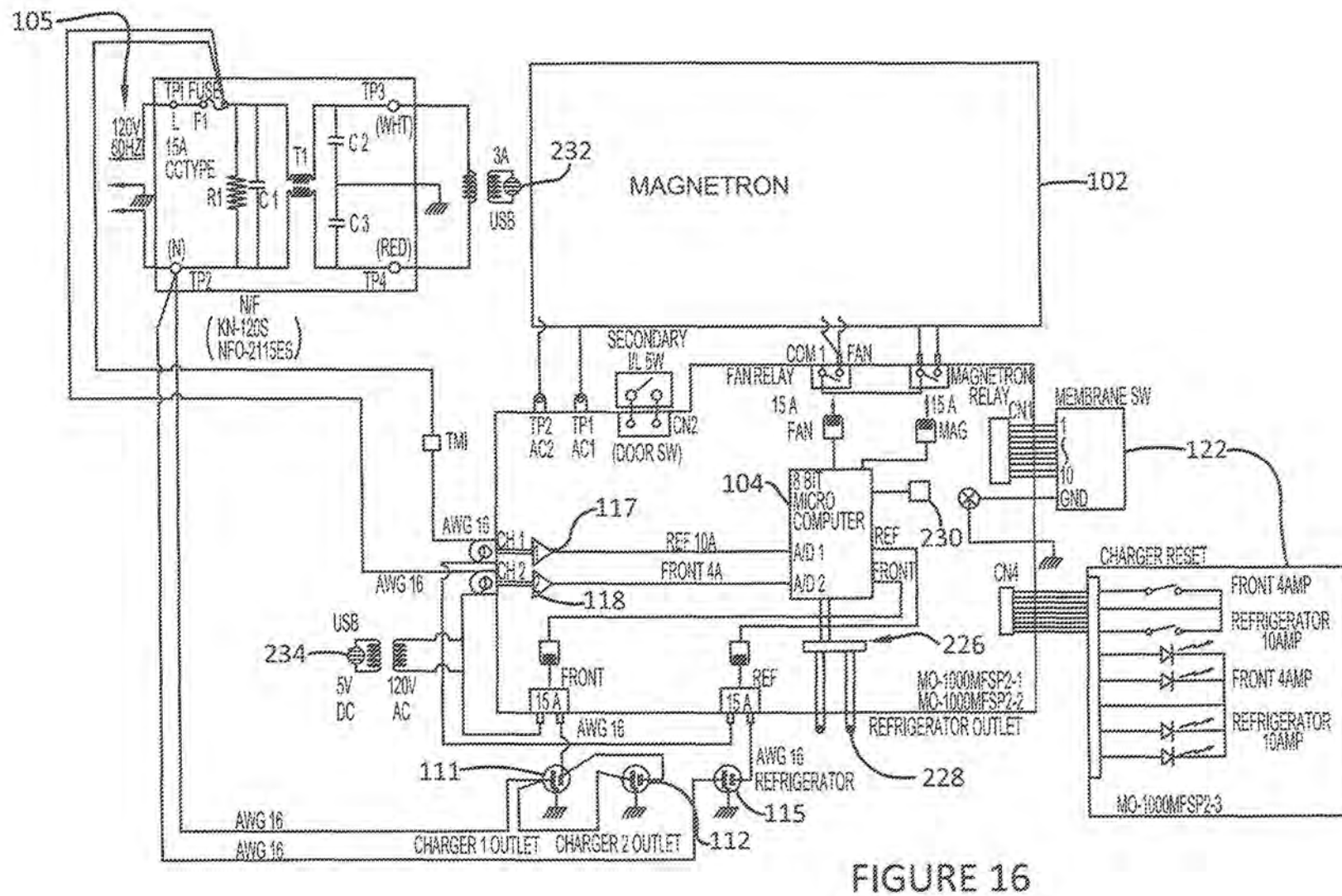


FIGURE 16

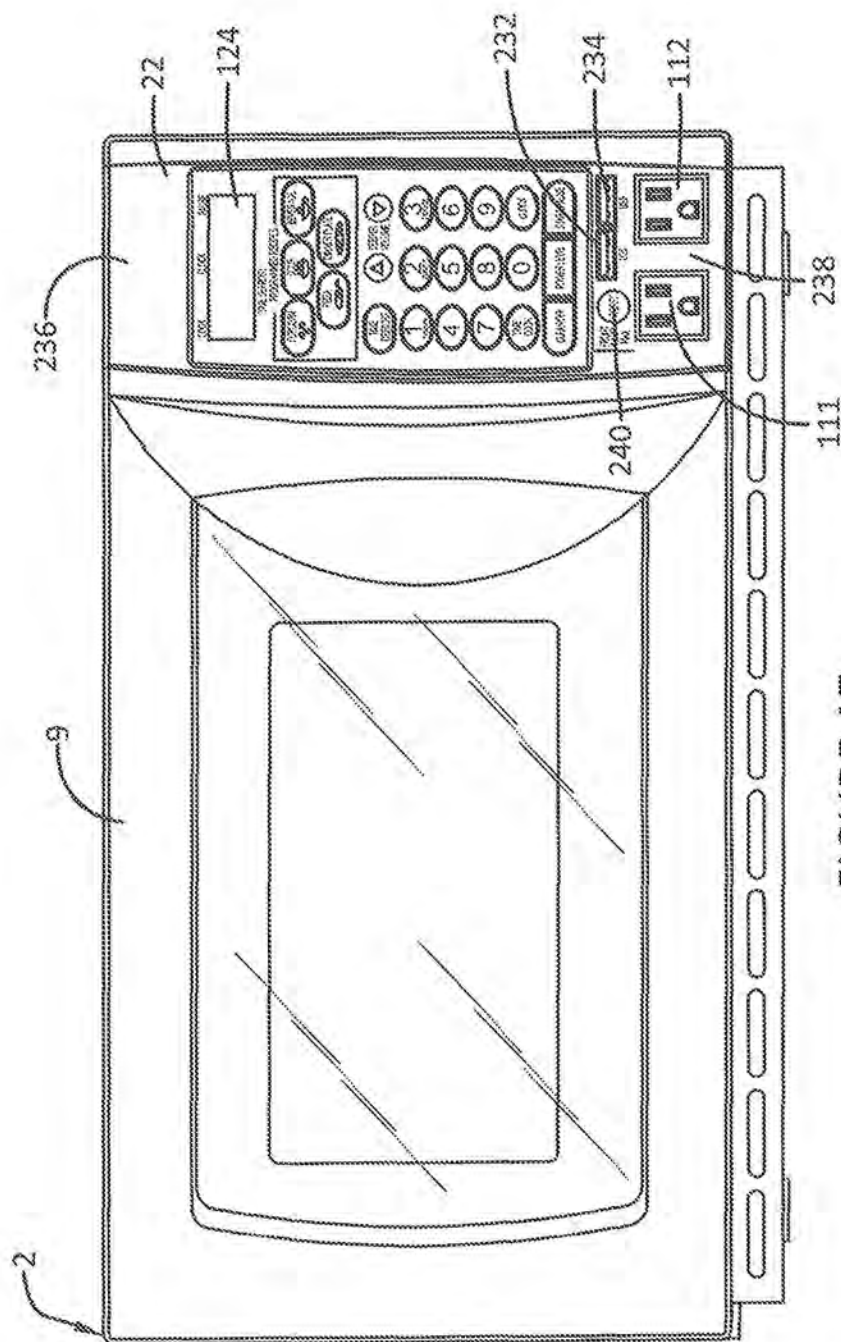


FIGURE 17

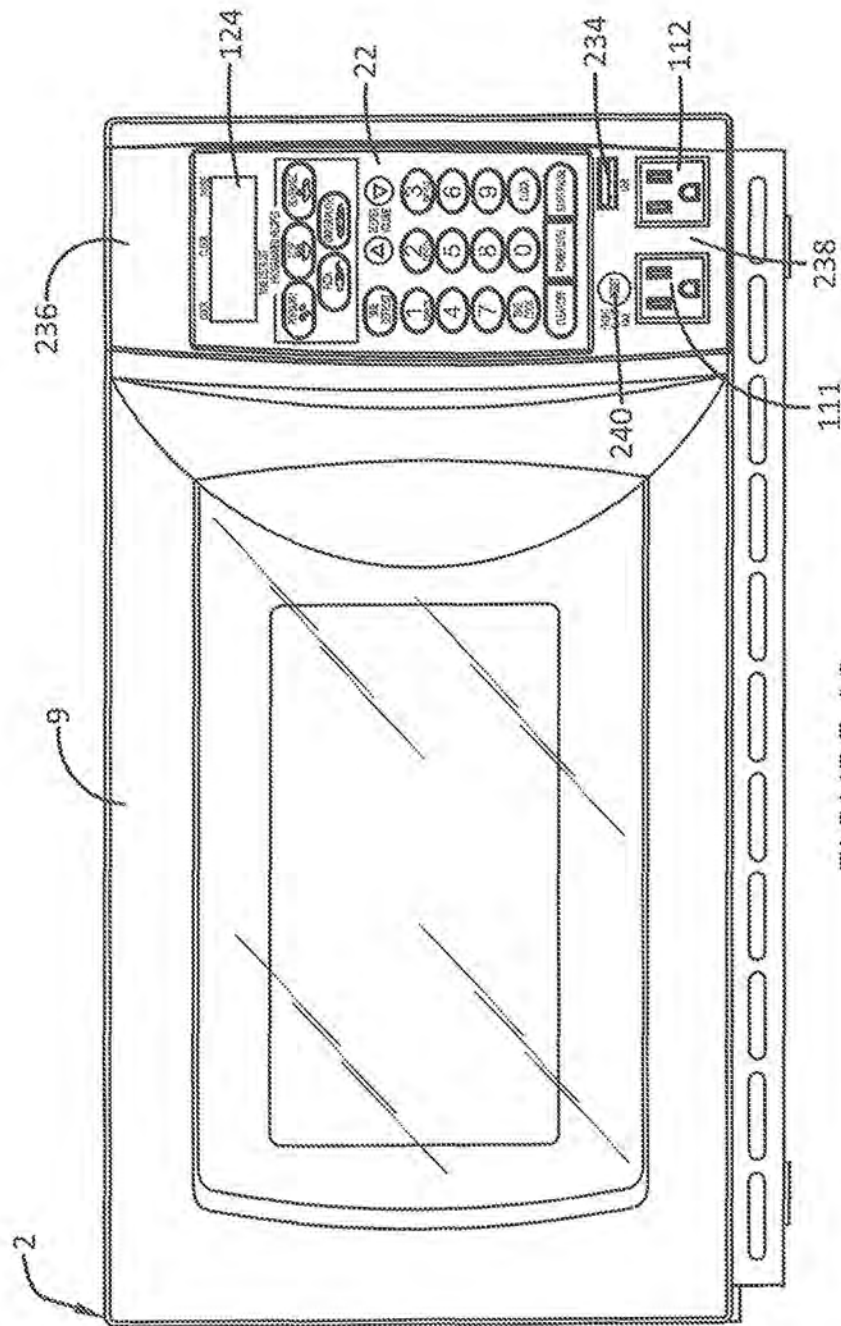
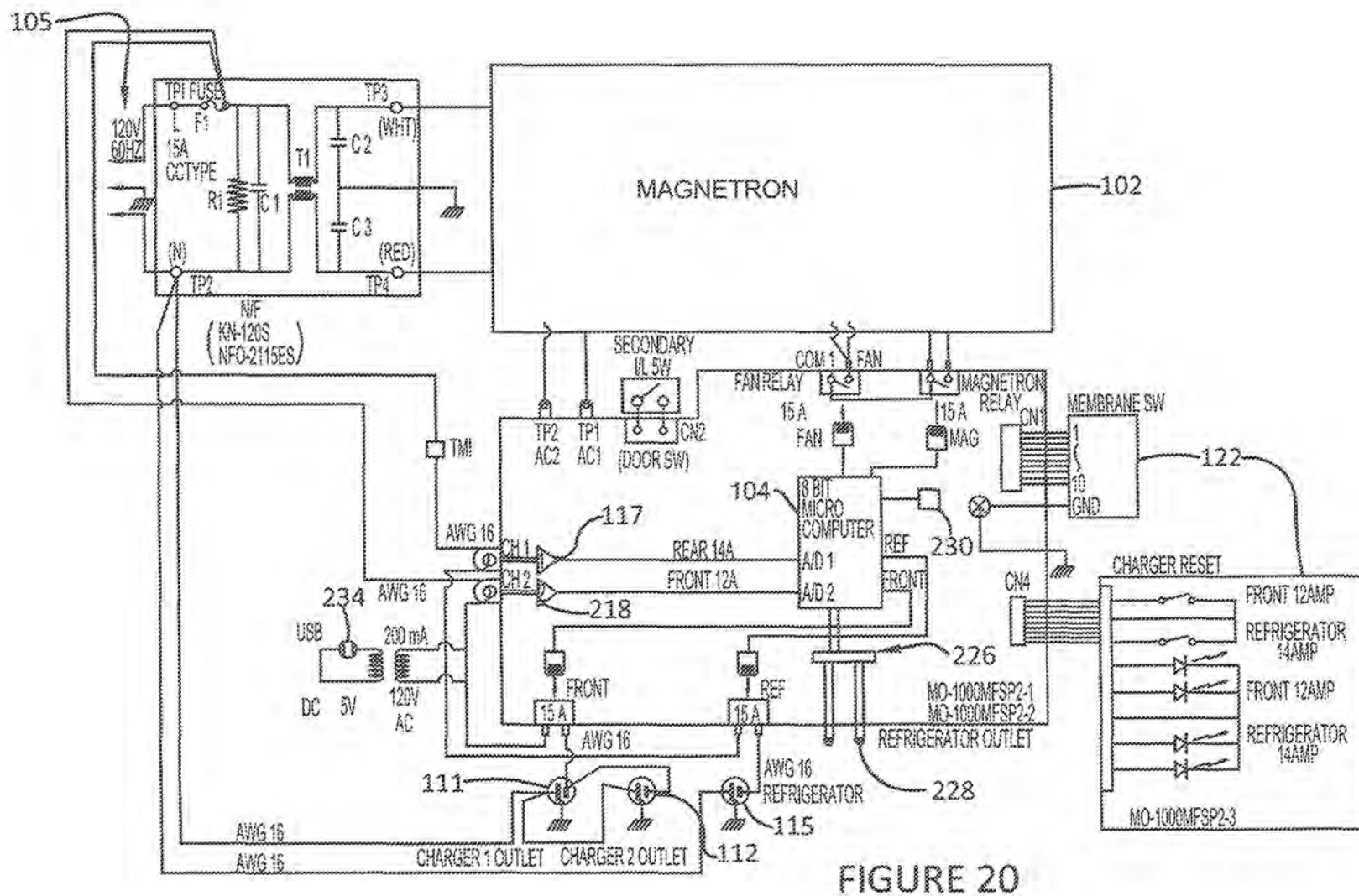


FIGURE 19



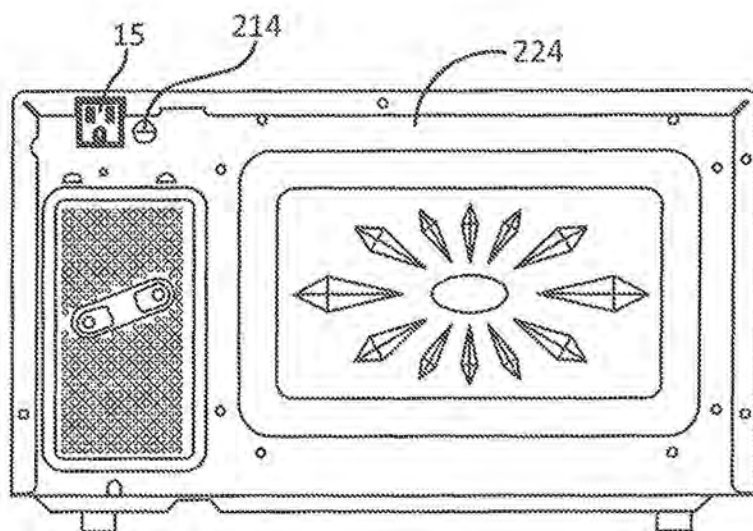


FIGURE 21

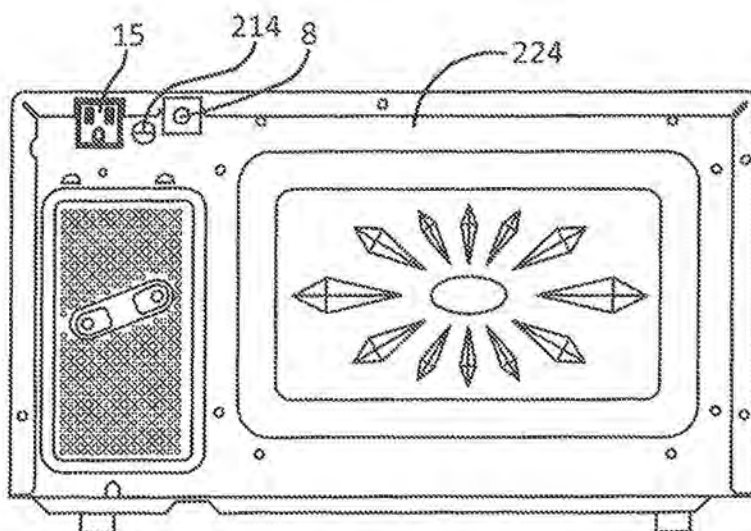


FIGURE 22

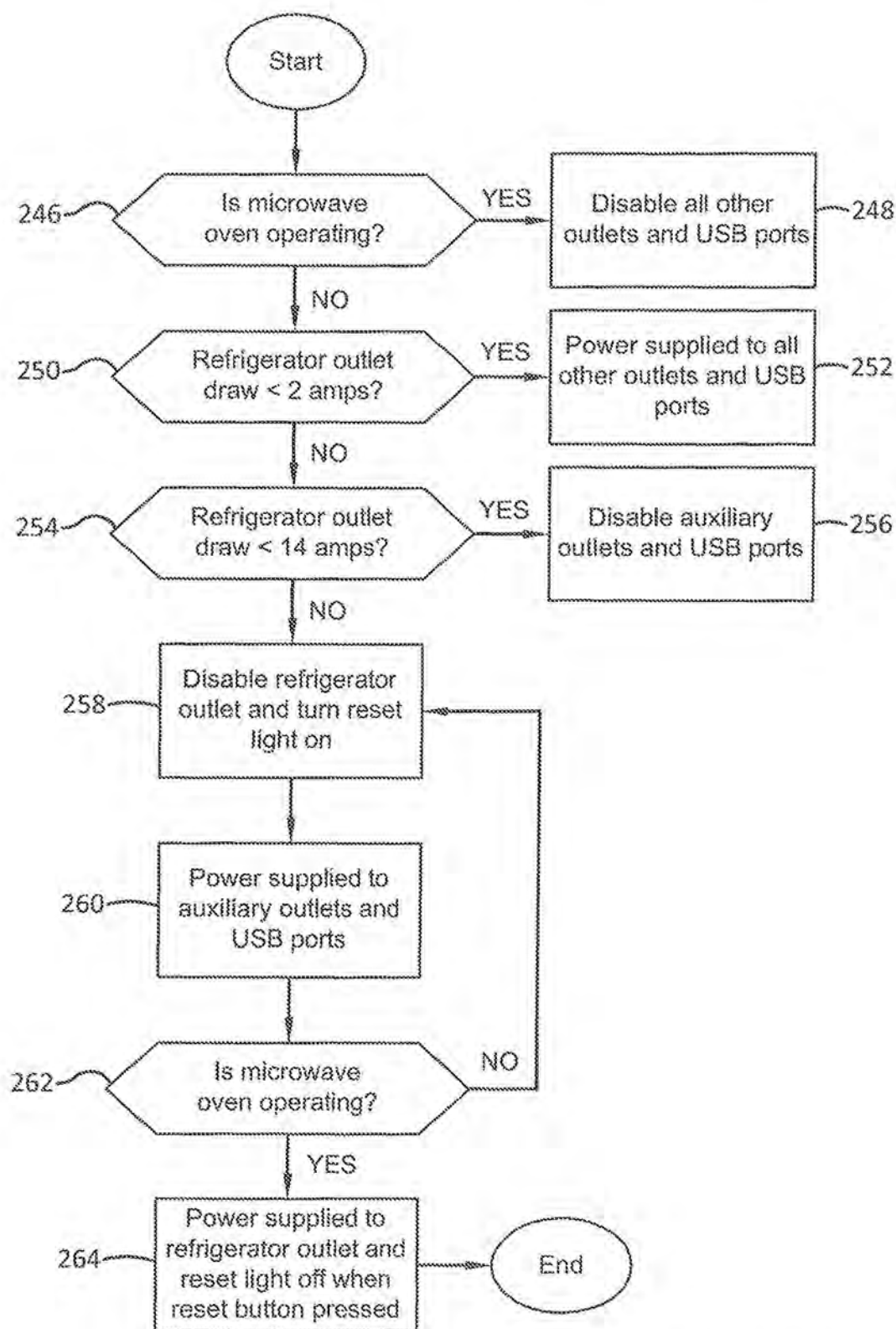


FIGURE 23

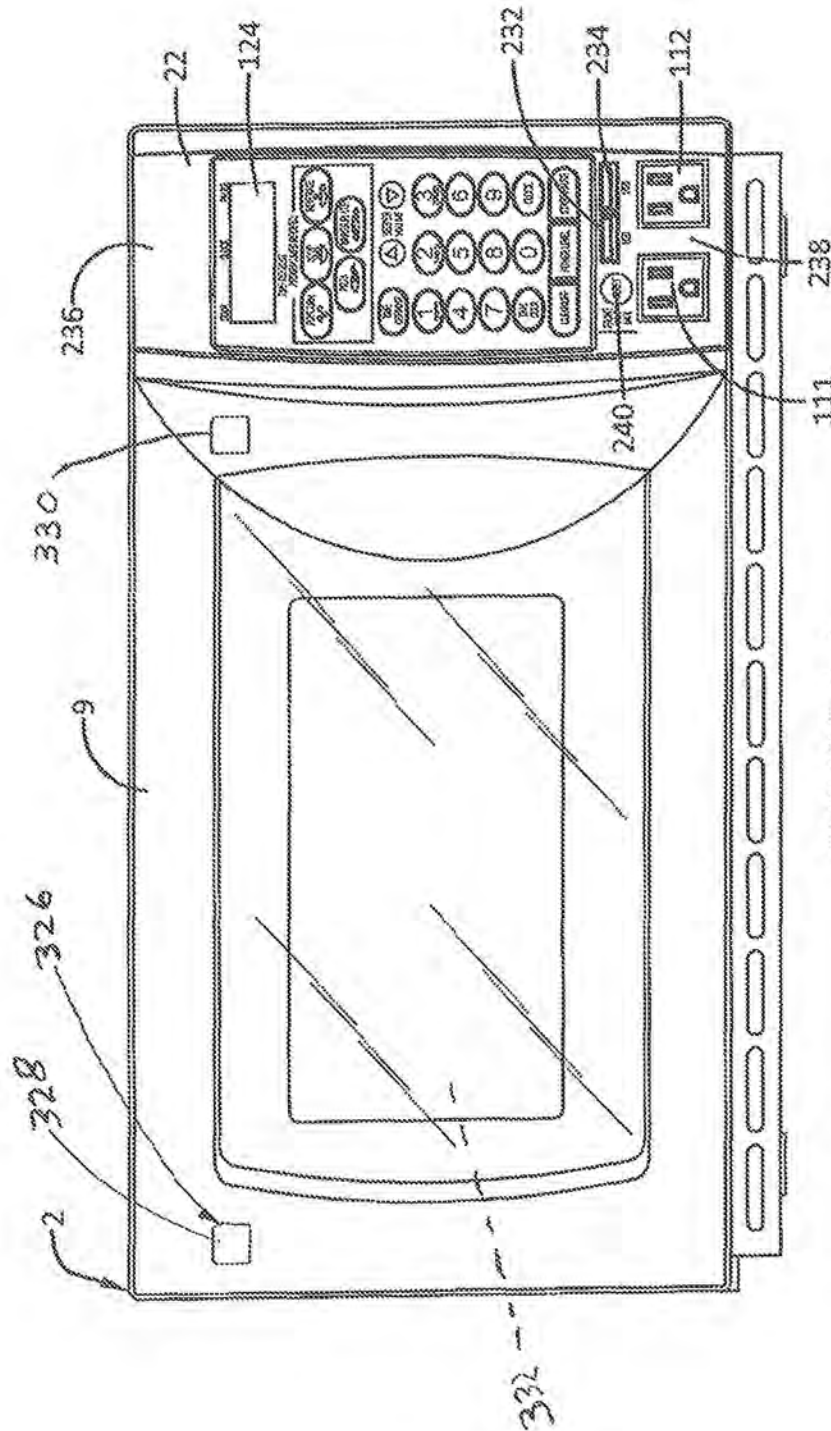
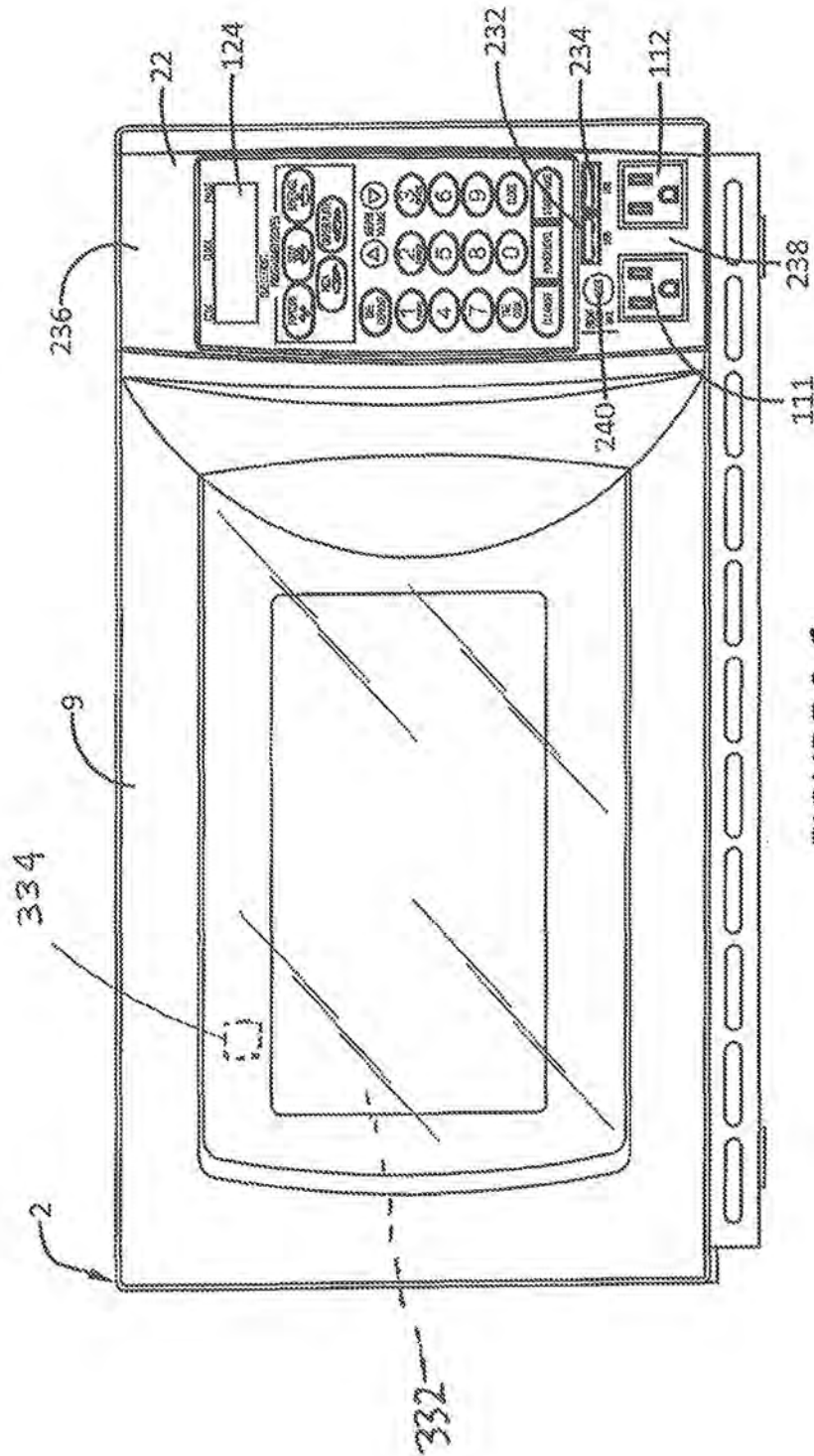


FIGURE 24



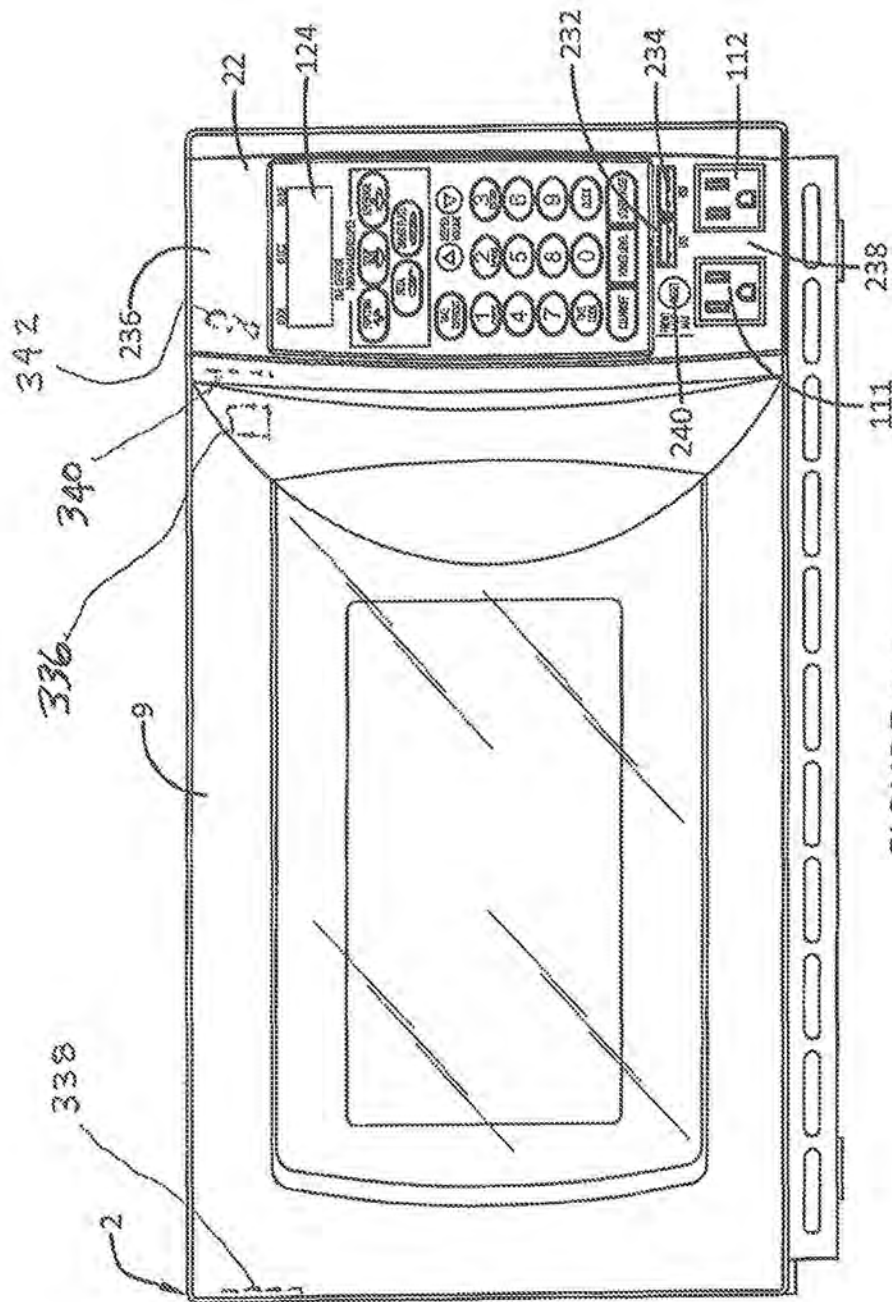


FIGURE 26

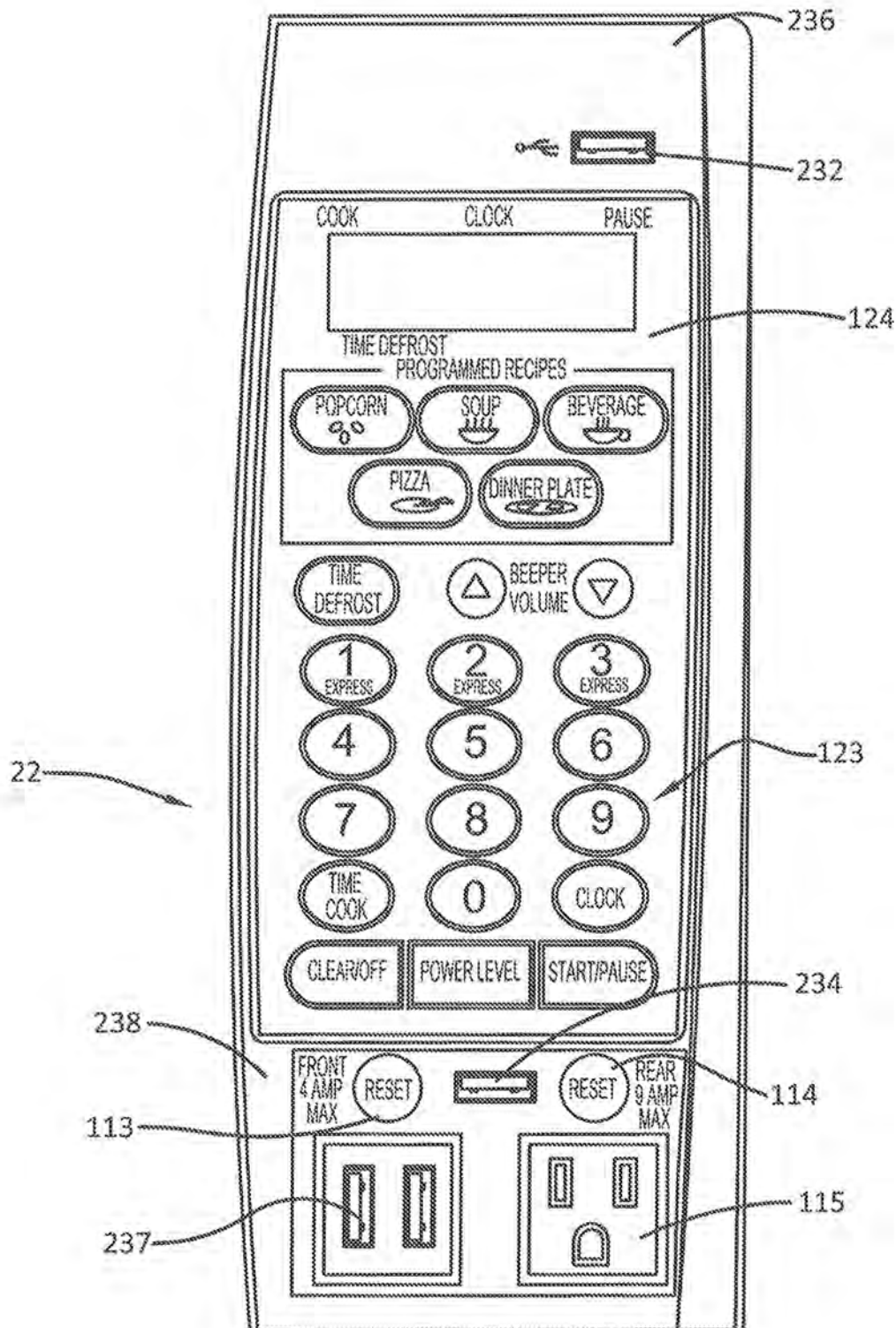


FIGURE 27

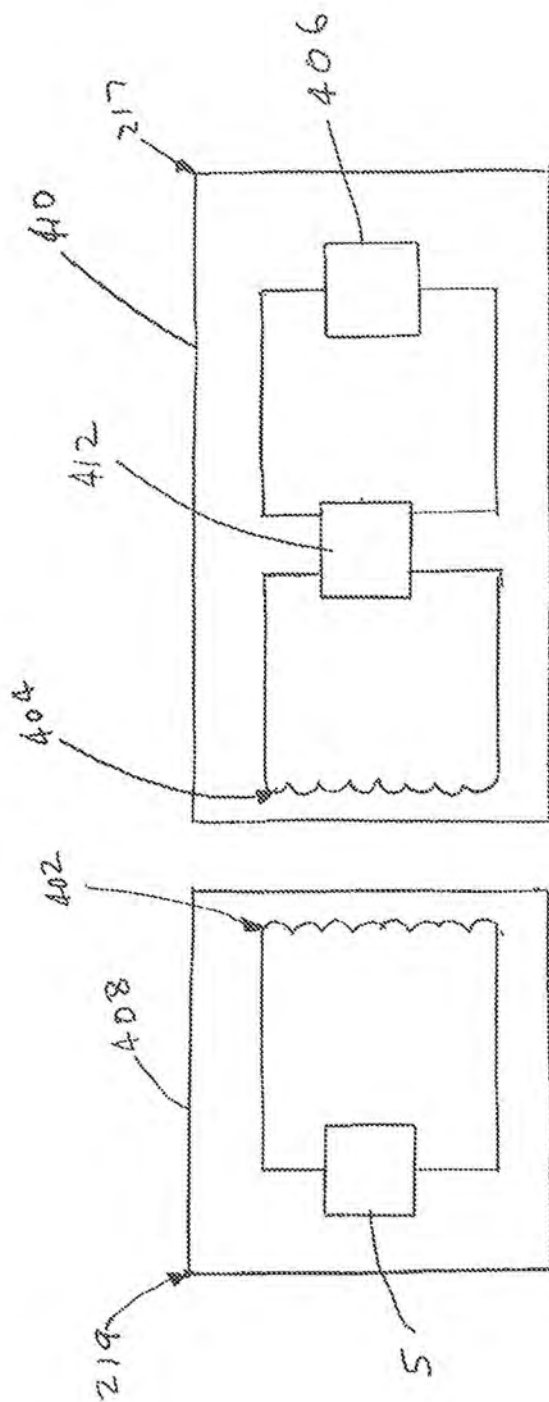


FIGURE 28

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MULTIPLE LINKED APPLIANCE WITH AUXILIARY OUTLET

TECHNICAL FIELD

Exemplary embodiments relate to improvements to appliances. Specifically, exemplary embodiments relate to improvements to appliances that include compact refrigerator and microwave oven functionality.

BACKGROUND

Compact refrigerators are used for many different purposes. They are often found in dormitories, hotels, offices and other establishments. Compact refrigerators are also often used in housing units for storage of beverages in bar areas or entertainment areas. Compact refrigerators provide useful storage for refrigerated items without the requirement for the considerable floor space and power draw that is required for a full size refrigerator.

Compact refrigerators and associated appliances may benefit from improvements.

SUMMARY

In one exemplary arrangement, an appliance apparatus is provided that includes a microwave oven. The microwave oven includes a radiation emitting microwave element and a microwave housing. The microwave housing bounds a cooking interior area. The radiation emitting microwave element is operative to irradiate the cooking interior area. The apparatus also includes a refrigerator. The refrigerator includes refrigerator housing. The refrigerator housing bounds a cooled refrigerator interior area. The refrigerator housing is in fixed operative mechanical connection with the microwave housing. The refrigerator includes a refrigerant compressor, or other refrigeration technology. The refrigerant compressor is operative to compress a refrigerant material. The refrigerant material is operative to cause cooling of the cooled refrigerator interior area. The apparatus includes at least one power control circuit. The at least one power control circuit is operative to cause electrical power to be selectively delivered to the microwave element and the compressor. One of the microwave element and compressor does not operate when the other of the microwave element and the compressor operates. A charging pad is provided on the microwave oven. The charging pad is configured for receiving an item to be charged by the charging pad. The microwave oven further includes at least one smoke sensor. In exemplary arrangements different types of smoke sensors may be used. An exemplary sensor includes a sensor emitter and at least one sensor receiver configured to receive radiation from the at least one smoke sensor emitter, wherein air of at least a portion of the cooking interior area extends intermediate of the at least one sensor emitter and the at least one sensor receiver. The apparatus also includes at least one safety circuit. The at least one safety circuit is in operative connection with the at least one sensor emitter, the at least one sensor receiver, and the microwave element. The at least one safety circuit is operative to cause the at least one sensor emitter to emit sensor radiation and the at least one sensor receiver to sense sensor radiation from the at least one sensor emitter while the microwave element operates during a cooking session. A determination is made that a transmission amount of sensor radiation from the at least one sensor emitter that reaches the at least one sensor receiver has fallen by at least a threshold amount during the cooking session,

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due to smoke in the cooking interior area. Responsive at least in part to the determination, the microwave element is no longer supplied with electrical power.

Other features may be included in exemplary arrangements.

BRIEF DESCRIPTION OF THE DRAWINGS

The system of the application is explained in more detail below with reference to the accompanying drawings, in which:

FIG. 1 is a front perspective view of an exemplary arrangement of an appliance system.

FIG. 2 is a rear perspective view of the arrangement of FIG. 1 showing an alternative arrangement.

FIG. 3 is a schematic block diagram of an arrangement of the exemplary system.

FIG. 4 is an electrical schematic diagram corresponding to the arrangement of FIG. 3.

FIG. 5 is a schematic logic flow diagram of an exemplary arrangement.

FIG. 6 is a schematic logic flow diagram of another exemplary arrangement.

FIG. 7 is a schematic logic flow diagram of another arrangement.

FIG. 8 is a graph illustrating the duty cycles of the components of the appliance in the system of FIG. 3.

FIG. 9 is a block diagram of an alternate arrangement.

FIG. 10 is an electrical schematic diagram of the arrangement of FIG. 9.

FIG. 11 is an illustration of a control panel of the arrangement of FIG. 9.

FIG. 12 is a front view of the microwave oven according to another arrangement.

FIG. 13 is a side view of the microwave oven door of FIG. 12.

FIG. 14 is a top perspective view of a charging pad on the top portion of a microwave oven.

FIG. 15 is an illustration of a control panel of an alternate arrangement.

FIG. 16 is an electrical schematic diagram of the arrangement of FIG. 15.

FIG. 17 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 18 is an electrical schematic diagram of the arrangement of FIG. 17.

FIG. 19 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 20 is an electrical schematic diagram of the arrangement of FIG. 19.

FIG. 21 is a rear view of the microwave oven according to the arrangements of FIGS. 12-19.

FIG. 22 is a similar view as that of FIG. 21 except that the AC cord is shown.

FIG. 23 is a schematic logic flow diagram of an exemplary arrangement.

FIG. 24 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 25 is a front view of the microwave oven according to another arrangement.

FIG. 26 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 27 is an illustration of a control panel of an alternate arrangement.

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FIG. 28 is a schematic diagram corresponding to the arrangement of FIG. 14 showing the charging pad and a device being charged.

DETAILED DESCRIPTION

A multiple linked appliance system 1, for example, an appliance that comprises a combination microwave oven 2 and refrigerator 3 incorporating features described in the present application illustrated in the Figures. Although exemplary arrangements will be described with reference to the features shown in the drawings, it should be understood that other arrangements may have many alternate forms. In addition, any suitable size, shape or type of elements or materials could be used. The computer or controller devices described in this application may be constructed having one or several processors and one or several program product modules stored in one or several memory elements. For illustration, computer or controller components may be described as individual units by function. It should be understood, that in some instances, these functional components may be separated or combined in other components.

In the exemplary arrangements, the circuits described herein may comprise one or more circuits including processors which for purposes hereof corresponds to any electronic device that is configured via circuit executable instructions that can be implemented in either hardware circuits, software, firmware or applications that are operative to enable the circuits to process data and carry out the other actions described herein. For example, the circuits may include circuits that correspond to one or more or a combination of a CPU, FPGA, ASIC or any other integrated circuit or other type or circuit that is capable of processing data. The processors may be included in a computer, server or other type of electronic device. Further, the circuits described herein may include data stores that correspond to one or more of volatile or non-volatile memories such as random access memory, flash memory, magnetic memory, optical memory, solid state memory or other devices that are operative to store computer executable instructions and data. Computer executable instructions may include instructions in any of a plurality of programming languages and formats including, without limitation, routines, subroutines, programs, threads of execution, objects, methodologies and functions which carry out the actions such as those described herein. Structures for the circuits and processors may include, correspond to and utilize the principles described in the textbook entitled *Microprocessor Architecture, Programming, and Applications with the 8085* by Ramesh S. Gaonker (Prentice Hall, 2002), which is incorporated herein by reference in its entirety. Of course it should be understood that these circuit structures are exemplary and in other embodiments, other circuit structures for storing, processing, resolving and outputting information may be used.

In exemplary arrangements the refrigerator may be connected to a power supply that provides a connection that enables the microwave oven to be connected to the same electrical supply. A single plug, therefore, may serve to connect both appliances and the current required for each appliance may be supplied by the same supply power cord and circuit. In exemplary embodiments power may be supplied by the 110V AC current outlet.

To make this combination attractive for use in dorm rooms, hotel rooms, recreational vehicles, tractor trailer cabs, and other similar locations, it may be necessary to assure that the peak current draws of both appliances are not demanded from the supply at the same time. Many house-

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hold circuits are protected from overload conditions by an automatic circuit breaker that is activated when current in the circuit exceeds the breaker rating. This is 15 amps in many circuits.

The duty cycle of an exemplary refrigerator used in these combined appliance systems includes a current spike that occurs during the first few seconds of operation. This is the start up current for the refrigerator compressor. The current draw is considerably reduced as the compressor attains its full operational speed. In typical refrigerator appliances the peak current may be in the range of 7 to 9 amps, while the steady state current may level off at 1.4 amps or less. A microwave oven demands a relatively steady 8 to 13 amps of cooking power during operation of the cooking element. It is apparent that an overload condition may occur when both appliances are placed in operation absent suitable control circuitry.

In an exemplary arrangement, a combination microwave and refrigerator appliance system is constructed having a single electrical plug input supply. The electrical supply in the exemplary arrangement is directly connected to the microwave oven. The microwave oven is adapted to provide power to the refrigerator through a power supply outlet, and to auxiliary receptacles adapted for connection to devices that operate at a low power operation draw. The microwave oven includes at least one control circuit including a processor based controller adapted to monitor operation of the refrigerator compressor and control the power to the microwave magnetron cooking element and other components. The current draws on the low power receptacles are separately monitored for control by the microwave controller. The microwave controller is adapted to balance the duty cycles of the connected appliances in operative connection therewith to avoid overload conditions. A control logic flow is implemented internally within the circuitry of the microwave controller. A receptacle or other power connecting power supply outlet for the refrigerator and the low power auxiliary receptacle may be implemented as part of the microwave control panel on the microwave oven.

In one arrangement, the auxiliary outlets are constructed to provide low power for the purpose of recharging batteries included in cellular mobile phones, personal media devices and digital cameras, in addition to operating lap top computers and other similar low power devices. The current to the auxiliary outlets is sensed by suitable circuitry in operative connection with the microwave controller.

In another exemplary arrangement, the power to the auxiliary outlets is disabled through operation of the microwave controller when the microwave magnetron is energized or whenever the current to the auxiliary outlets exceeds a preset value.

In one exemplary arrangement, a programmed control model for control logic flow is established and executed by the microwave controller. The model is dependent on the state of operation of the microwave cooking element or elements which are referred to herein as a magnetron. As part of the exemplary control model, the power draw of the compressor is monitored to sense operation of the compressor to compress refrigerant to provide cooling. When cooking power is demanded by the microwave the compressor is disabled by having electrical power thereto withdrawn by the at least one control circuit for a preset minimum period. When power demand to the magnetron ceases, refrigerator compressor power is restored provided that the preset minimum period has expired.

In another exemplary arrangement of the control model, sensing circuits are operative to monitor current draw on the

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auxiliary outlets. The control model is adapted to cause the controller to disable the power to the auxiliary receptacles, if the microwave magnetron is in operation. In addition the auxiliary receptacles are disabled if a predetermined maximum current draw is sensed. Another control model is based on operation of the refrigerator and operates to disable the auxiliary receptacles when the compressor is in the start up mode. Of course these approaches are exemplary and in other arrangements, other approaches may be used. Further while in the exemplary arrangement the at least one control circuit which is included in the controller is integrated with the microwave oven, in other arrangements the controller may be integrated with the refrigerator or other device, or may be configured as a separate component.

In one aspect of an exemplary arrangement, a non-transitory processor readable medium having processor executable program instructions embodied therein for operating at least one processor of a control circuit to control an appliance system of multiple linked components including a microwave oven, a refrigerator, and an auxiliary power supply outlet is provided. The processor executable program code causes the control circuit to disable the refrigerator and the auxiliary power supply outlet, when the microwave demands high power such as magnetron cooking power, and enable power delivery from the auxiliary power supply outlet when the microwave is not drawing cooking power.

One exemplary arrangement of a multi-component interconnected appliance system 1 is illustrated in FIG. 1. This arrangement consists of two components, a refrigerator 3 and a microwave oven 2. Refrigerator 3 is electrically connected to microwave oven 2 by power cord 7 to refrigerator receptacle 15, shown at the rear of the microwave 2 in FIG. 2. Refrigerator 3 is generally subject to control by the microwave microprocessor controller which is alternatively referred to herein as a power control circuit 4 of the microwave oven 2. The power control circuit may be operative to cause electrical power to be selectively delivered to and/or withheld from the microwave magnetron and the refrigerator compressor. A single power cord 8 provides input electrical power to the system 1 from receptacle 5 which provides a source of electrical power, through microwave 2. In the case where stand alone components are used, as shown in FIGS. 1 and 2, microwave oven 2 is connected directly to power source 5. The refrigerator 3, as the heaviest component, is used as the base with the microwave oven 2 stacked on top. In the selection of the refrigerator 3, it would be advantageous in some arrangements for the height of the refrigerator to be no more than 48 inches above the floor. This provides a more ergonomic operation of the microwave oven 2 for the user. In addition, in the stacked position of the components in an exemplary arrangement, the doors 9 and 10 of the microwave 2 and refrigerator 3, respectively, are arranged in a common plane.

At least one power control circuit 4 serves as a controller for the operation of the microwave oven 2 and is also adapted to control the other components of system 1, as shown in FIG. 3. Power is distributed throughout the system 1 under control of microwave controller 4 and digitally operated switches such as relays 19 and 20 represented in FIG. 3. It should be understood that in some arrangements the relays may control power delivery via mechanical contacts while in other embodiments, solid state relays may be used. Power is distributed to each of the appliance components 2 and 3, and to auxiliary low power receptacles 11 and 12. In use lamps 13 and 14 in the form of LEDs or the like may be positioned adjacent to the auxiliary receptacles to indicate power being available from the adjacent receptacle

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or power to the receptacle being disabled. The low power auxiliary receptacles 11 and 12 are provided to permit convenient access for plugging in a low power device, for example, devices including rechargeable batteries, such as cellular phones, PDAs, or other electronic devices that do not demand high power. As shown in the graph of FIG. 8, there are instances during which, if more than one of the appliances is in use, the cumulative current would cause an overload condition.

An exemplary control panel 22 of microwave oven 2 may be adapted to provide a display of the particular status of the controlling relays. For example, LEDs 13 and 14 may indicate that power to the outlets 11 and 12 are disabled or available. In one exemplary arrangement the lamps will light when power is available at the outlet and flash when disabled. In another exemplary arrangement the lamps will light when power is not available at the outlet and not activate when power is available at the outlet as a means to reduce the standby power draw. A button operated touch panel is used in the exemplary arrangement to provide manual control.

As shown in FIG. 4, in order to control the power to the microwave 2, refrigerator 3 and receptacles 11 and 12, sensing circuits, may be coupled to the at least one control circuit to monitor current draw by the appliance components and the auxiliary receptacles. A relay 20 is connected in the power line to the refrigerator and may be actuated by signals from controller 4. In particular, according to an exemplary arrangement, sensing circuits 16, as shown in FIG. 4, have sensors 17 and 18 coupled to the power line of the auxiliary outlets 11 and 12 to monitor the current being drawn by a connected device. Sensors 17 and 18 may include current sensing transformers of the type available from Triad Magnetics of Corona, Calif. The signals generated by sensors 17 and 18 may be used to activate switches or other control components, such as relays 19. Relays 19 may be actuated by the at least one control circuit 4 to enable and disable the delivery of power to the low power auxiliary outlets 11 and 12 in response to signals from sensors 17 and 18. A maximum current may be set through the program logic associated with the at least one power control circuit 4 to prevent overload of the outlets 11 and 12. In one arrangement of the system, the maximum current limit is set at 2 amps, and the control circuitry is operated to cease power delivery in situations where the power draw exceeds this amount. Of course this approach is exemplary.

In another exemplary arrangement, a clock function 21 included in the at least one power control circuit 4 is used to provide timed delays during which, for example, refrigerator 3 would be prevented from undesirably rapid on/off cycles. When the compressor of the refrigerator 3 is disabled during microwave cooking operation, a time delay of 3 minutes is provided during which the compressor of the refrigerator 3 will remain disabled, even if microwave use is only for a short period. Control circuit 4 may be programmed to manage the power delivery to the components of the appliance to avoid overload conditions, while minimizing disruptions in the use of an individual appliance component. A model of operative events and related control operations may be designed into the program instructions executed by at least one control circuit 4 to provide a control methodology as illustrated in FIGS. 5-7.

In one exemplary arrangement, as illustrated in the block diagram of FIG. 3, at least one control circuit 4, constructed as part of the controller for microwave 2, is adapted to receive and process the sensor signals and identify particular events in the system 1 related to a particular appliance

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component or combination of appliance component conditions. Circuit 4 controls the power to microwave 2 and refrigerator 3 and also low power receptacles 11 and 12 to avoid overload conditions. The circuit 4 is operative to execute the control methods illustrated and described below. In one exemplary arrangement, the circuit 4 is operative to control operations of microwave oven 2 and is adapted to execute the program instructions described below. The at least one control circuit is coupled directly to refrigerator outlet 15 and low power outlets 11 and 12.

In one exemplary arrangement, shown in FIG. 1, the outlets 11, and 12, are included as part of the front control panel of microwave oven 2. In FIG. 2, in another arrangement, the auxiliary receptacles 11 and 12 and refrigerator receptacle 15 are accessible at the rear of the microwave oven 2. In these alternative arrangements, the microwave oven 2 is connected by supply cord 8 directly to power supply receptacle 5. Refrigerator 3 is connected by power cord 7 to receptacle 15 on microwave oven 2 as shown in FIG. 2.

In one exemplary arrangement, control models for program logic flows are established as shown in FIGS. 5-7 for execution by the at least one control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware associated with the circuit 4. The models shown are, in the first instance, dependent on the state of operation of microwave oven 2. The current demands of the microwave 2 when drawing cooking power are generally the most significant contribution to overload, as shown in FIG. 8. To avoid overload conditions, power to the low power receptacles 11 and 12 and refrigerator receptacle 15 is disabled during microwave magnetron operation. If the refrigerator 3 compressor is drawing power when the microwave 2 is turned on to commence cooking, the power to the refrigerator compressor is turned off and clock function 21 is used to determine a predetermined period during which the compressor of refrigerator 3 cannot be restarted. A time delay, for example, of 3 minutes, may be set through programming of the at least one control circuit and when this delay period has expired, receptacle 15 may again be enabled, providing the control circuit determines in accordance with its programming and sensed parameters that microwave cooking operation has ceased. This prevents a too rapid restart of the compressor that may otherwise result in damage.

In some exemplary arrangements, the at least one control circuit of the power controller may operate responsive to sensing the power draw of the refrigerator and the cooking element of the microwave oven so as to detect the power draw reaching a threshold which should not be exceeded to prevent an overload condition. In other exemplary arrangements, the control circuitry may operate to detect inputs that may be provided by input devices and which are operative to cause power drawing components of devices such as the magnetron of the microwave oven or the compressor of the refrigerator to operate. In such arrangements, the control circuitry may operate to detect the signal from a thermostat within the refrigerator which indicates that the thermostat is signaling that the refrigerant compressor should operate to cause the temperature to be lowered within the cooling area of the refrigerator. In such arrangements, the at least one control circuit may operate to detect the signal from the thermostat and prevent the delivery of power to the compressor in situations where the cooking element of the microwave oven is operating. In such arrangements the control circuitry may delay the supply of power to the

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compressor until the cooking element of the microwave oven has ceased operation. Likewise in an exemplary arrangement the at least one control circuit may be operative to detect inputs to at least one input device of the control panel of the microwave which are provided by a user to commence microwave operation. In response to the detection of such inputs, the exemplary control circuitry may be operative to first cause a determination to be made as to whether the refrigerator is drawing the level of power that indicates that the compressor thereof is operating. In response to a determination that the refrigerator is drawing a level of power that is incompatible with operation of the microwave cooking element, the exemplary control circuitry may be operative to cause power to the refrigerator compressor to be withdrawn. Thereafter the at least one control circuit may be operative to cause power to be supplied to the cooking element of the microwave. Further in exemplary arrangements, the at least one control circuit may also monitor the power draw of auxiliary outlets or other power delivery points to assure that the level of draw that is currently occurring will not be an impediment to an operation that is being requested by an input device of the apparatus before the apparatus begins to operate in a manner that will cause increased power draw. Thus the exemplary appliance apparatus enables the preventative action of discontinuing operation of a power drawing component before instituting operation of another component that draws a high level of power. Of course it should be understood that this approach is exemplary and in other arrangements, other approaches may be used.

In the arrangement shown in FIG. 5, if low power is demanded at receptacle 11 or 12 and microwave oven 2 is not in use for cooking, power is supplied to the low power receptacles, provided further, that the current demand at an individual outlet does not exceed a preset limit, for example, 2 amps. Since the auxiliary outlets may be enabled during refrigerator compressor operation, there may be an overload generated at peak compressor operation. In one arrangement the at least one control circuit acts to disable the auxiliary outlets during compressor startup to prevent accidental overload of the system. Therefore as illustrated in the logic flow diagram of FIG. 5, control circuitry may be adapted to check the operational status of the refrigerator, as well as the microwave oven, prior to enabling the auxiliary outlets.

FIGS. 9-11 illustrate another exemplary arrangement. In this arrangement the sensing components 117 and 118 are configured to reduce the risk of overload by the combined demands of the auxiliary outlets 111 and 112 and the refrigerator outlet 115. In the exemplary configuration as shown in FIG. 10, current sensor 117 is configured to monitor the current draw through the refrigerator outlet 115 and the circuitry is operative to limit the refrigerator current draw at the outlet 115 so that it does not exceed 10 amps. Current sensor 118 is connected to monitor the combined current in the auxiliary outlets 111 and 112. Current sensor 118 and the control circuitry is configured to limit the combined auxiliary outlet current draw to 4 amps. In this manner the risk of overload is minimized. As represented in the block diagram of FIG. 9, the microwave 102 has at least one control circuit comprising controller 104 that is operatively connected to power supply 105. Clock function 121 which is shown schematically separately but may be part of the controller provides a timing device to determine a restart delay for power to refrigerator 103. Sensing circuit/sensor 117 is configured to monitor the current demanded by refrigerator 103 and sensing circuit/sensor 118 is connected to low power receptacles 111 and 112 is operative to monitor

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the combined current draw on receptacles 111 and 112. In the exemplary arrangement the control circuitry is shown as operative to control the availability of electrical power to some devices as a whole. For example, if the at least one control circuit operates to cause power not to be available to the refrigerator, all components of the refrigerator, such as the internal lights, air circulation fan, etc., are not supplied with electrical power, in addition to the compressor, which is the component which is most likely to draw power at a level which may be excessive. However in other arrangements, the at least one control circuit may be configured to deliver and withhold power selectively to individual refrigerator components or groups of such components. Thus in such arrangements the power control circuitry may be operative to withdraw power to the high power draw component(s) such as the compressor, while still making power available to other low power draw components such as the internal fan and/or lights.

Likewise in exemplary arrangements, the power control circuitry is operative to selectively allow power to be available or withdrawn from components of the microwave oven. For example, exemplary arrangements control the availability of power to selected components of the microwave oven such as the magnetron and the auxiliary outlets. The at least one power control circuit of exemplary arrangements may operate to maintain electrical operation of certain components, even though electrical power to other components is not available. For example, an exemplary controller may operate to maintain power to the clock display output on the control panel at all times. Further some exemplary arrangements may assure that power is maintained to control circuitry with programmed settings so that programmed data is not lost. This may include for example programmed data concerning a future time to turn on the cooking function, the power level and/or how long to cook. This way if the memory of the microwave has been programmed to begin to cook a food item placed inside the microwave oven at a future time so it is cooked by the time a person returns (for example) the programmed instructions to carry out those instructions will not be lost. Alternatively, configuration data that enables the microwave oven controller to communicate in a wireless network or with other devices will be preserved even though the control circuitry operates to cause electrical power not to be available to certain components. Of course these are merely examples.

It should be understood that for purposes hereof when it is stated that power is withdrawn or not made available to a microwave oven, refrigerator or other assembly of components, the terminology refers to not making such power available to the entire assembly or to only certain selected components that draw high power such as the refrigerant compressor or magnetron. Likewise herein references to the microwave or the refrigerator operating or running refers to operation of the respective high power draw components such as the magnetron or the compressor, for example.

In an exemplary arrangement, as shown in FIG. 11, a control panel 122 is arranged with at least one input device in the form of a keypad 123 for manual control and a display 124. Auxiliary outlet 111 is shown as accessible from the front and is associated with a status LED indicator and reset button 113 that may be caused to be operative during use and switch to a flashing mode when the microwave is drawing cooking power. Refrigerator outlet 115 is also accessible on the exemplary front panel and is associated with an LED indicator and reset button 114. Similarly LED indicator 114 is controlled to be on by being illuminated during use of the refrigerator and to switch to a flashing mode when the

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microwave is drawing cooking power. In another exemplary arrangement, the status LED indicator and reset button 113 may be caused to be off during use and switched on or to a flashing mode when the microwave magnetron is drawing cooking power. Similarly, in this arrangement, the LED indicator 114 is controlled to be off during operation of the refrigerator compressor and switched on or to a flashing mode when the microwave radiation cooking element is operating.

A further exemplary arrangement of the logic flow operational model is shown in FIG. 6. In this model, the refrigerator compressor draws or demands power. This may be triggered by a temperature rise of the refrigerator interior area within the housing of the refrigerator and involve start up of the refrigerator compressor with an associated peak power demand. If the microwave cooking element is sensed by the control circuitry as currently drawing cooking power, the programming of the control circuitry causes power not to be available the refrigerator so that operation of the refrigerator compressor will be delayed. If the microwave cooking element was on and subsequently cycled off, the clock function 21 must be checked by the controller to determine if power availability to the refrigerator to restart can occur. Under some circumstances, it may be necessary to give the refrigerator compressor priority to prevent an undesirable rise in temperature. In the latter instance, the at least one control circuit can be coupled to the refrigerator temperature sensor to execute a programmed sequence during which the microwave cooking element will be disabled by not having power supplied thereto to allow the refrigerator to operate long enough to return to proper operating temperatures.

In the exemplary arrangement of FIG. 7, the exemplary control circuitry operates to give priority to the power demands of the microwave oven, as indicated above. Use of the receptacles 11, 12, and 15 are, therefore, caused to be disabled during microwave cooking operation. The operational models which carry out the logic represented in FIGS. 5-7, may be established by logic flows implemented by instructions that are programmed or imbedded in the control circuitry of controller 4.

In this manner an appliance system of linked components, including a microwave oven, refrigerator, and at least one low power draw device or appliance may all be connected through a common supply cord to a releasably connectable receptacle providing a source of house current or other electrical power level without the risk of inconvenient interruptions or damage during use caused by overloads.

It is also advantageous to provide such a combination microwave/refrigerator system that also provides auxiliary outlets for low power applications, such as for the purpose of recharging batteries in cellular phones, operating lap top computers and other low power devices, while controlling the operation of the appliance to avoid overload conditions.

In another exemplary arrangement as illustrated in FIGS. 12 and 13, the auxiliary outlets or electrical power receptacles 211, 212 may be included as part of the front control panel 222 of the microwave oven 202 and located on the upper portion 270 of the front control panel 222. The auxiliary outlets 211, 212, front control panel 222 and microwave oven 202 are similar to auxiliary outlets 11, 12, front control panel 22, and microwave oven 2 except as discussed below. In this exemplary arrangement, the auxiliary outlets 211, 212 are positioned side by side with respect to each other with each of the auxiliary outlets 211, 212 being at the same height as the other. The auxiliary outlet 211 of FIG. 12 may be associated with a status LED indicator and reset button 213, which is located on the lower

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portion 272 of the front control panel and in vertical alignment with the auxiliary outlet 211. The status LED indicator and reset button 213 may be caused by the control circuitry of the controller to be on during use and switched to a flashing mode to indicate that power is not available therefrom when the microwave oven 202 is drawing cooking power. The auxiliary outlet 212 of FIG. 12 may be associated with status LED and reset button 214, which is located on the lower portion of the front control panel and in vertical alignment with the auxiliary outlet 212. The status LED indicator and reset button 214 may be caused by the controller to be on during use and switched to a flashing mode to indicate that power is not available therefrom when the microwave oven 202 is drawing cooking power thereto is withdrawn. In another exemplary arrangement, the status LED indicator and reset button 213 may be caused to be off during the time power is available for use and switched on or to a flashing mode when the microwave oven is running and power thereto is withdrawn. Similarly, in another arrangement, the status LED indicator and reset button 214 may be caused to be off during power availability and switched on or to a flashing mode when the microwave oven is running or the refrigerator is running and the controller causes power not to be available. Other elements and operational features may be similar in structure and function as that of the arrangements shown in FIGS. 1-11. Thus, the same reference numbers will be used in this exemplary arrangement to indicate elements that are similar in the arrangements shown in FIGS. 1-11.

Smart technology may be integrated in some of the exemplary arrangements. For example, a user may be able to monitor and/or control the refrigerator 3 such as by turning it on and off remotely by a remote device 217. The remote device 217 may include a hand held device such as a cellular phone. The cell phone may also be a smart phone. In some exemplary arrangements, the refrigerator, the microwave and/or the controller may include circuitry suitable for communication in a wireless network. Such a wireless network may be established in the facility, residence, office or other location where the combined refrigerator and microwave appliance is operated. Such devices may include circuitry that enables transmission of wireless signals to and from such components. Such communications may include communications of operational properties such as operating status, temperature, programmed values or other information that is pertinent to the operational condition of the particular device. In further exemplary arrangements, circuitry may be operative to enable received wireless messages to modify the operational condition and/or the programming of the particular device.

For example in some exemplary arrangements, the user may be able to communicate from a wireless phone via cellular or WiFi connection to determine that the refrigerator is operating, the temperature therein, the operational status of the compressor or other items. Alternatively and/or in addition, the user may be able to remotely control components of the refrigerator. These may include, for example, the ability to remotely turn on the internal light within the refrigerator and to view the food items currently housed within the refrigerator via one or more electronic cameras positioned therein. This may enable a user, for example, to determine that they need to purchase additional groceries or other items for purposes of an upcoming meal or other activities. Alternatively and/or in addition, in some exemplary arrangements, instructions may be utilized to change the temperature within the refrigerator. This may be done,

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for example, to chill certain grocery items that may need to be cooled or frozen for certain purposes. Of course these approaches are exemplary.

Likewise the microwave oven may include interface circuitry which enables the remote monitoring of the condition of the microwave oven components via a remote wireless device. This may include, for example, determining the periods of past operation and current status of the microwave oven such as whether it is currently being used to cook items. Alternatively and/or in addition, the remote monitoring capabilities may include determining the programmed status of the controller of the microwave oven such as the controller being programmed to cook an item housed in the microwave oven at a set future time or for a particular duration at a particular power level. Alternatively and/or in addition, the remote operational capabilities associated with the microwave control circuitry may include the ability to turn on an internal light within the cooking chamber of the microwave oven and to view via a camera whether an item is contained therein. Further such remote capabilities may also include the ability to remotely change the program parameters so as to initiate cooking at a different time or at a different power level. Likewise exemplary arrangements may include having the wireless interface in operative connection with the at least one power control circuit to provide the ability to monitor the current status of power draw on auxiliary outlets, the occurrence of alarm conditions, or the current status of other connected devices. It should be understood that such capabilities may be implemented in the controller circuitry or in separate circuitry of the microwave oven and/or the refrigerator. Further the exemplary arrangements may utilize communications interface capabilities included in circuitry of the controller to facilitate monitoring and operational control of the appliance. Of course these capabilities are exemplary and in other arrangements, other approaches may be used.

In an exemplary arrangement a charging pad 219 (FIG. 14) may be provided on the microwave oven 2 or other suitable location to receive a smart phone or other chargeable device for purposes of charging the device. For example, a wireless charging pad 219 may be positioned on top 225 of the microwave oven 2 for recharging the smart phone or other device. The charging pad 219 may be built into the top 225 of the microwave oven 2 or may be a separate component that is mounted to the top 225 of the microwave oven 2 or other location. The exemplary charging pad 219 includes an inductive charging pad and includes a recessed area 220 for receiving an item to be charged such as the smart phone. The at least one control circuit may include or be in operative connection with a wireless interface 221 configured for communicating with the remote control device 217 for controlling the microwave oven or refrigerator and work in conjunction with the control circuitry to perform functions such as removing the supply of electrical power to the microwave oven 2 and/or refrigerator 3. In an exemplary arrangement, USB ports 223, 224 may be provided in the area of the charging pad 219. Alternatively, or in addition, power outlets may be provided in proximity to the charging pad 219. Alternatively, the charging pad 219 may be provided on the front, side, rear or bottom of the microwave oven 2, or at another suitable location in connection with the combined appliance structure.

The exemplary charging pad 219 may utilize inductive or wireless charging, which uses an electromagnetic field to transfer energy between the charging pad 219 and the device being charged. In general, the charging pad 219 may include a primary inductive coil 222 (FIG. 28) in connection with

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circuitry that is operative to create an alternating electromagnetic field that is received by a secondary inductive coil 404 (FIG. 28) connected to the circuitry of the device being charged such as device 217. Power from the electromagnetic field is converted back into electric current to charge a battery 406 (FIG. 28) in the device. FIG. 28 shows an exemplary arrangement in which the charging pad 219 utilizes inductive charging to charge the device 217. In this arrangement, the charging pad 219 includes an inductive charging station 408 and the primary inductive coil 402. The power source 5 provides electrical power to the inductive charging station 408 and the other components of the charging pad 219.

The inductive charging station 408 is provided for inductively charging the device 217 and may be built into or otherwise attached to the charging pad 219. The inductive charging station 408 may include the primary inductive coil 402 that is connected to the power source 5 for the microwave oven 2. The recessed area 220 may define a cover of the charging pad 219 that covers the primary inductive coil 402 and provide a surface on which the remote device 217 may be placed for charging. The inductive charging station 408 may also include one or more capacitors coupled in series and/or parallel with the primary inductive coil 402 to form an LC circuit. The inductance value of the primary inductive coil 402 and the capacitance value of the capacitor or capacitors may be selected to achieve a desired resonant frequency which corresponds to a frequency of a coil and circuitry in the device being charged, but it should be noted that this exemplary arrangement is not limited to any particular inductance and/or capacitance values and/or any particular power source ratings.

The device 217 or other device to be charged may include the battery 406 that provides electrical power to the components and circuitry of the device. The battery 406 may comprise a rechargeable battery or batteries including lead acid, nickel cadmium (NiCad), nickel metal hydride (NiMH), lithium ion (Li-ion) or lithium ion polymer (Li-ion polymer) batteries. The device may include any number of batteries, the size and rating of which may vary. The battery 406 may also comprise power conduits, connectors, receptacles, battery connectors, or power cables coupled with batteries.

The device 217 or other device to be charged may include an inductive charger 410 for charging the battery 406 when the device 217 is placed on or in the vicinity of the inductive charging station 408 of the charging pad 219. The inductive charger 410 may be built into or otherwise attached to the device to be charged. As schematically represented in FIG. 28, the inductive charger 410 may include the secondary inductive coil 404 and a charging circuit 412 that is connected to the battery 406. The inductance value of the secondary inductive coil 404 may be selected to correspond or complement the inductance value of the primary inductive coil 402, but it should be noted that in exemplary arrangements the secondary inductive coil is not limited to any particular inductance value. Likewise, the power rating of the charging circuit 412 may be selected to match or complement the rating of the battery 406. The two inductive coils 402, 404 in proximity combine to operate in a manner similar to the principles employed in an electrical transformer. Further in some arrangements greater distances between primary and secondary inductive coils and/or more effective charging can be achieved when the inductive charging system uses resonant inductive coupling. Of course the described approaches are exemplary and in other arrangements other approaches may be used. In some exem-

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plary arrangements the charging pad may be in operative connection with the at least one control circuit that controls power availability to components of the device. For example, the control circuitry may operate in accordance with its programmed instructions to cause power to not be available to the charging pad when the microwave draws cooking power. Alternatively or in addition the control circuitry may be operative to cause power not to be available to the charging pad responsive to power draw by the refrigerator compressor, the auxiliary outlets or other items, and/or cumulative power draw of multiple items.

As shown in FIGS. 16, 18, and 20, a safety sensor which is alternatively referred to herein as a safety circuit 226 such as a smoke or gas sensor may be provided in connection with the microwave oven 2. The smoke sensor 226 operates in connection with exemplary at least one control circuit to turn off the microwave oven upon sensing smoke or polluted air indicative of a potentially dangerous condition such as excessive smoke generated from overcooked food. The exemplary safety sensor 226 may be powered on or otherwise operational when the microwave oven is in operation. The sensor circuitry may operate responsive to processor executable instructions to determine the optimal activation point. The exemplary smoke sensor may be battery-powered or powered by the house current that powers the combined appliance with an optional battery backup when the power from the house current is out. The smoke sensor may include an ionization smoke sensor that uses a radioisotope, typically Americium-241, to ionize air. The exemplary ionization smoke sensor circuitry operates to turn off power to the magnetron cooking element of the microwave oven upon sensing a difference due to smoke indicative of a potentially dangerous condition. The smoke sensor alternatively may include a radiation type smoke detector that may contain a source emitter of infrared, visible, or ultraviolet light (typically an incandescent light bulb or light-emitting diode), a lens, and a photoelectric or other type of radiation sensing receiver (typically a photodiode) and suitable control circuitry.

An exemplary sensor 226 may include an alcohol sensor that is coupled with a thermistor 228. An exemplary alcohol sensor 226 may operate in a set temperature range, such as from 32 to 104 degrees Fahrenheit. When a set level of heating is sensed by the thermistor 228, the thermistor 228 through suitable control circuitry causes the alcohol sensor 226 to turn on and become operational and check for properties of the gas within the interior area of the microwave.

If the exemplary alcohol sensor 226 is operational due to the sensing of the set level of heating and senses polluted air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor to the controller 104. Upon receiving the shutdown signal, the controller 104 determines that the radiation cooking emitting element of the microwave oven 2 should be shut down and causes the magnetron of the microwave to shut down through the withdrawal of electrical power. If (after the alcohol sensor is caused to be turned on by the thermistor) the alcohol sensor 226 senses air that is not indicative of a dangerous condition such as the air produced by normal cooking of food in the microwave oven 2, the alcohol sensor circuitry will not send a shutdown signal to the controller 104 and the controller allows the microwave cooking activity to continue.

Alternatively or in addition, a fault indicator 230 may be coupled to the control circuitry of the controller 104 or other circuitry to indicate that there is a dangerous condition upon detection by the alcohol sensor 226. For example, the fault

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indicator 230 may be an audible indicator such as a buzzer that is activated in response to the alcohol sensor 226 sensing polluted air indicative of a dangerous condition. In another example, fault indicator 230 may include the display 124 displaying a fault message such as "E-1" in response to the alcohol sensor 226 detecting polluted air indicative of a dangerous condition. Alternatively the fault indicator may output one or more signals, such as wireless alarm signals that can be detected by a receiver of an alarm system or through a remote device such as a smart phone.

An exemplary arrangement may include a combination of fault indicators. For example, upon the alcohol sensor 226 sensing air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor 226 to the controller 104. Upon receiving the shutdown signal, the controller 104 determines that the microwave oven 2 should be shut down and causes the radiation emitting cooking element of microwave oven 2 to be shut down. In addition in an exemplary arrangement, a buzzer is activated and the display 124 displays a fault message such as "E-1" in response to the alcohol sensor 226 sensing polluted air indicative of a dangerous condition.

The alcohol sensor 226 may be reset automatically responsive to the alcohol sensor 226 no longer detecting gas indicative of the dangerous condition. Alternatively or in addition, the alcohol sensor 226 may be reset upon sensing by a suitable switch, opening of the microwave door 9 of the microwave oven 2. The display may display a "bar" or other suitable icon to indicate that the alcohol sensor 226 is turned on. Other types of suitable safety sensors may also be used instead of the alcohol sensor to detect a dangerous condition within the cooking area of the microwave.

In addition to one or more sensors which detect the gases generated from cooked food, the sensor 226 may include a temperature sensing capability such as, for example, using the thermistor 228 and related elements mentioned above.

Referring to FIG. 24, in another exemplary arrangement, the safety sensor which is alternatively referred to as a safety circuit may comprise an infrared sensor 326. The infrared sensor 326 may include two oppositely positioned infra-red disposed infrared sensor elements in the form of a sensor emitter 328 and sensor receiver 330 (schematically shown in FIG. 24) provided on the microwave oven and located in the microwave's cavity 332. The exemplary infrared sensor 326 operates as follows. The sensor emitter 328 emits radiation and the sensor receiver 330 senses sensor radiation from the sensor emitter 328 while the microwave element operates during a cooking session. When smoke that is indicative of a dangerous condition passes in between the infrared sensor elements 328, 330, a determination is made by the safety circuit that a transmission amount of sensor radiation from the sensor emitter reaching the sensor receiver has fallen by at least a programmed threshold amount during the cooking session, due to smoke in the cooking interior area. Responsive to the determination, the cooking element of the microwave oven is caused by the safety circuit to be no longer supplied with electrical power. The exemplary safety circuit may use the smoke point of oil or similar food products as the basis for its threshold amount, so that normal smoke emitted during the cooking or heating of food or beverages will not cause the infrared sensor 326 to deactivate cooking operation. The exemplary infrared sensor 326 would not require interaction from the microwave user. The exemplary safety sensor may be operative to cause an initial transmissivity level of sensor radiation that reaches the sensor receiver from the sensor emitter early in the cooking session to be stored in a data store or other memory associated with

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the safety circuit. The determination of a level of smoke corresponding to a dangerous condition is made in this embodiment responsive to circuitry operating in accordance with programmed instructions to detect that the transmission amount of sensor radiation reaching the sensor receiver has dropped by the threshold amount from the initial transmissivity level during the cooking session.

Referring to FIG. 25, in another exemplary arrangement, the safety sensor or safety circuit may comprise a light sensor 334, which detects the increase smoke density within the microwave's cooking area which is alternatively referred to as a cavity. The light sensor 334 may also include a sensor emitter and sensor receiver. The light sensor 334 may be provided in the microwave cavity 332 and may operate as follows. At the beginning of a cooking cycle, the light generated travels through the clean air to the light sensor 334. As smoke increases in density, the amount of light that reaches the sensor receiver is reduced. The circuitry of light sensor 334 includes a programmed trip point or threshold that corresponds to the reduced amount of light sensed caused by the amount of smoke, that is indicative of a dangerous condition. When the trip point is reached, the safety circuit causes the electrical power to the radiation emitting cooking element to be withdrawn. A circuit determination would be made based on the amount of smoke that corresponds to the trip point and its corresponding light sensor reading.

Referring to FIG. 26, in another exemplary arrangement, the safety sensor may include an optical motion sensor 336. The optical motion sensor 336 may also include a sensor emitter and sensor receiver. The optical motion sensor 336 may be positioned in the microwave cavity 332 adjacent air exhaust vents 338, 340 of the microwave, which comprises an air passage that connects an area where food is cooked in the microwave oven to the air outside the housing of the microwave oven. The optical motion sensor 336 detects motion which is sensed due to the presence of smoke blown by an exhaust fan 342 of the microwave oven 2 through the air passage. The exhaust fan 342 is operative to cause air to move in the air passage connected to the microwave cavity. In an exemplary arrangement, the sensor emitter and sensor receiver are positioned to be operative to sense the transmission of radiation between the emitter and the receiver in the air passage. The optical motion sensor 336 has a trip point or threshold that corresponds to the presence of smoke of a predetermined density that corresponds to a reduced level of transmission that is indicative of a dangerous condition. When the trip point is reached, the optical motion sensor in combination with the control circuitry causes the cooking element of the microwave oven to be turned off. It should be noted that the exemplary optical motion sensor is not be positioned within the microwave cavity and directed toward a turntable therein, since the turntable itself may result in false alarms in some configurations. Of course it should be understood that other types of smoke sensors may be positioned in air passages in other alternative arrangements.

Alternative arrangements may include other types of smoke sensors. For example, some arrangements may include sensors that are operative to detect smoke by determining the level of volatile organic compounds (VOCs) in the air in the microwave oven cooking area. In some exemplary arrangements such VOC sensors may be positioned to sense air in at least a portion of the microwave cooking area. In some cases such VOC sensors may be positioned in an air passage that extends between the microwave cooking area and the air in the atmosphere outside the

microwave. Such an arrangement may have an advantage in that positioning the sensor in the air passage may minimize the amount of cooking splatter and other contamination from the food cooked in the microwave oven that reaches the sensor.

Some exemplary arrangements may include a VOC sensor that comprises a tin dioxide semiconductor gas sensor. In some arrangements the semiconductor is formed on an alumina substrate with a thick film heater of ruthenium oxide on the reverse side. Of course this configuration is exemplary and in other arrangements other configurations and VOC sensor types may be used.

In exemplary microwave oven arrangements VOC sensors may be operated in conjunction with at least one suitable control circuit to detect conditions which correspond to a dangerous smoke condition. Such a dangerous smoke condition is determined responsive to the level of VOCs, such as carbon dioxide and/or carbon monoxide in the air in the cooking area of the microwave oven. Such compounds may generally indicate the presence of combustion which is corresponds to a potentially dangerous condition. Responsive to detecting a threshold VOC concentration in the air of the cooking area, the control circuitry in operative connection with the sensor is operative to cause power to be withdrawn from the magnetron of the microwave oven so as to prematurely end a current cooking session before the set and time thereof. In exemplary arrangements, the sensitivity of the VOC sensors is sufficient to detect a developing potentially dangerous condition and cause power to be withdrawn from the microwave cooking element before a fire or other condition causes damage to the microwave oven. This enables the sensor circuitry to reset when the dangerous smoke condition is no longer detected and enable the microwave oven to operate in a subsequent cooking session.

In some exemplary arrangements multiple sensors in operative connection with detection circuitry is utilized to determine the activation point for an alarm condition based on detection of parameters such as humidity, temperature, temperature rate of change, and gas constituents generated during cooking phases. Combinations of absolute and relative values and rates of change thereof may be detected for purposes of evaluating possible alarm conditions. Other types of sensors that may be used in exemplary arrangements include flame sensors. Flame sensors are operative, detect and provide signals indicative of the presence of a flame or fire. Upon the flame sensor detecting the presence of a flame, the flame sensor causes at least one control circuit to discontinue electrical power to the microwave oven cooking element. In some arrangements the flame sensor may take the form of an optical flame sensor. The flame sensor may be of the type that utilizes ionization current flame detection. Alternatively, the flame sensor may be of the type that utilizes thermocouple flame detection.

Alternatively or in addition, the fault indicator 230 may be coupled to the controller 104 or other circuitry to indicate that there is a dangerous condition upon detection of a potentially dangerous condition by any of the infrared sensor 326, light sensor 334, optical motion sensor 336, or flame or fire sensor in the arrangements described above. For example, the fault indicator 230 may be an audible indicator such as a buzzer that is activated in response to the safety sensor 226 sensing polluted air indicative of a dangerous condition. In another example, fault indicator 230 may include the display 124 displaying a fault message such as "E-1" in response to the safety sensor 226 detecting polluted air indicative of a dangerous condition.

Exemplary arrangements may include a combination of fault indicators. For example, upon the trip point or threshold value being reached by any of the detection circuitry of the infrared sensor 326, light sensor 334, or optical motion sensor 336, a shutdown signal is outputted by the sensor 226 to the controller circuitry 104. Upon receiving the shutdown signal, the controller 104 determines that the microwave oven 2 should be shut down and causes electricity to be withdrawn from the cooking element. In addition, a buzzer is activated and the display 124 displays a fault message such as "E-1" in response to the sensor 226 sensing polluted air indicative of a dangerous condition. In other exemplary arrangements, the controller or other circuitry may be operative to output signals that can be communicated to a remote location, indicative of an alarm condition that is detected through one or more detection circuits of the microwave oven or other connected devices. This may include, for example, the circuitry dispatching messages to a remote device such as a smart phone of a user. The messages caused to be dispatched responsive to operation of the control circuitry may be indicative of an alarm condition that can be output on the display of the user's device to advise that a potentially dangerous condition exists. Alternatively and/or in addition, the control circuitry may be operative to communicate messages to a central controller or alarm panel located in the facility or institution in which the microwave is operated. For example the circuitry may be operative to provide wireless communication to an alarm panel or central monitoring station which receives the information that there is a potentially dangerous condition at the microwave device located in a particular location, dormitory room or other identified area of the building or facility. In still other exemplary arrangements, messages corresponding to alarm conditions that are cause to be sent by the control circuitry of exemplary arrangements may be dispatched to devices or alarm monitoring stations of a security force for an oversight authority within the area in which the microwave is operated. Of course it should be understood that these approaches are exemplary and in other arrangements, other approaches may be used.

Exemplary arrangements may also include the features described in U.S. patent application Ser. No. 15/239,378 filed Aug. 17, 2016 which is published as US Patent Publications 2017-0059233 the disclosure of which is incorporated herein by reference in its entirety. In some exemplary arrangements an appliance like that shown in the incorporated disclosure may include a safe which is suitable for holding valuables or a user's rechargeable devices such as a smart phone. In some exemplary arrangements the safe may include a smoke sensor, heat sensor, flame sensor or other type sensor that is operative to detect a fire or other dangerous condition within the interior area of the safe. Further in exemplary arrangements the at least one control circuit or other circuitry may be operative to dispatch messages to a user's smart phone or other remote computer device to indicate such a fire or other dangerous condition within the interior area of the safe. In addition in exemplary arrangements the at least one control circuit or safe circuitry as described in the incorporated disclosure, may operate an audible alarm to give at least one audible signal of the dangerous condition. Also in exemplary arrangements messages may be dispatched to alarm monitoring stations associated with the building or institution in which the appliance is located. Further in exemplary arrangements a remote notification to a user's mobile device or other computer and/or to an alarm monitoring station may also be given in circumstances in which at least one danger sensor or one of

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the types of the incorporated disclosure is operative to sense a safe tamper condition. In such circumstances the at least one safe circuit or other circuitry may be operative to cause a remote notification of the tamper condition to be given and/or an audible signal to be output from an audible alarm. Further in exemplary arrangements one or more cameras may be in operative connection with the control circuitry to provide to the user's mobile device or other remote computer and/or to an alarm monitoring station, images associated with the detected condition. These may include images captured by cameras with a field of view outside the safe or the microwave oven or refrigerator of the combined appliance. Alternatively or additionally in other arrangements cameras may be positioned to capture images of an interior area of the safe. In some arrangements this may include a camera that is operative to have a field of view directed at or through the safe opening so that in the event that the safe is opened by an unauthorized person, images of the individual who is responsible for breaking into the safe may be captured. Further in exemplary arrangements the signals may be provided by the safe circuitry which can operate on a battery if the safe is disconnected from the combined appliance and no longer receives power from the at least one power control circuit thereof. Further the safe circuit may also provide GPS or other position signals so that the location of the safe can be tracked. Of course it should be understood that these approaches are exemplary and other arrangements other approaches may be used.

The exemplary detection circuitry of the smoke sensor, infrared sensor 326, light sensor 334, or optical motion sensor 336, may be reset automatically upon the sensor not detecting gas or other conditions that are no longer indicative of the dangerous condition. Alternatively or in addition, the sensor may be reset upon circuitry sensing opening of the microwave door 9 of the microwave oven 2. The display may display a "bar" or other suitable icon to indicate that the sensor is turned on. Other types of suitable safety sensors and circuitry may also be used to detect dangerous conditions. Further in other exemplary arrangements, other circuitry may be in operative connection with the combined appliance or separate components so as to address dangerous conditions. Such items may include, for example, a suitable fire extinguishing system that may be automatically triggered in response to detecting conditions corresponding to fire or smoke within the cooking chamber of the microwave oven. For example in some exemplary arrangements, a compressed supply of carbon dioxide may be included with or be positioned adjacent to the combined appliance. A suitable gas conduit and control valve may be positioned to deliver the carbon dioxide into the cooking chamber of the microwave oven responsive to the detection of flame, excessive temperature or smoke within the microwave cooking chamber. Suitable circuitry in operative connection with the controller or circuitry of the temperature, smoke or flame detection devices may operate to cause the control valve for the delivery of the carbon dioxide or other fire extinguishing material to be opened to cause the delivery thereof responsive at least in part to the detection of one or more of the alarm conditions. Further as can be appreciated, in some exemplary arrangements, the control circuitry may operate in accordance with its programmed instructions to require that the alarm condition be detected as existing for a programmed period of time before the control circuitry operates to cause the fire extinguishing material to be delivered into the cooking chamber. Further although exemplary arrangements may include carbon dioxide as the fire extinguishing material, in other embodiments other types of

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fire extinguishing or fire suppressing materials may be utilized. These may include, for example, chemical fire extinguishing or retarding materials in the form of powders or foams. Alternatively, and/or in addition, fire suppressing materials may include the delivery of nonflammable gaseous material. Of course these approaches are exemplary and in other embodiments, other approaches may be used.

As shown in FIGS. 15, 16 and 27, the exemplary front control panel 22 of the microwave oven 2 may include Universal Serial Bus (USB) ports 232, 234 for connection, communication, and power supply between the front control panel 22 and electronic devices such as a personal computer, cell phone, Smart Phone, iPod®, iPad®, or other suitable device to allow communication and/or charging of the electronic device plugged into the USB ports. In one exemplary arrangement, a first USB port 232 may be provided on the upper portion 236 of the front control panel 22, and a second USB port 234 may be provided on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112 and between the reset buttons 113, 114 as seen in FIG. 15. The first USB port 232 may be operatively connected to a three ampere fuse and a linear time-variant system (LVT) of 100 mA, 120 volts, and 12 watts. The second USB port 234 may be operatively connected to a linear time-variant system (LVT) of 200 mA, 120 volts, and 24 watts. The second USB port 234 may also be reset. The current sensor 118 may be constructed to limit the second USB port and the two auxiliary outlets to 12 amps. The USB ports 232, 234 may be in operative connection with respective printed circuit boards. Alternatively, as represented in FIG. 27, instead of auxiliary outlet 111, another USB port 237 may be provided on the front panel 22 at the location of the auxiliary outlet 111. Alternatively or in addition, one or more USB ports may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively or in addition, one or more auxiliary outlets may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively, the refrigerator outlet may be provided on the top, bottom, or one of the sides of the microwave oven.

FIGS. 17 and 18 show another exemplary arrangement of a control panel and control circuitry that includes USB ports 232, 234. In this arrangement, the first and second USB ports 232, 234 are located side by side on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112. The USB ports 232, 234 are also located rightwardly (as viewed in FIG. 17) adjacent a status LED indicator and reset button 240. In this exemplary arrangement, current sensor 218 is configured to monitor the combined current in the USB ports 232, 234 and the auxiliary outlets 111 and 112. The current sensor 218 is constructed to limit the combined current in the USB ports and auxiliary outlets 111 and 112, to 12 amperes. The LED indicator and reset button 240 may be controlled to illuminate when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and flash when disabled. In another arrangement, the LED indicator and reset button 240 may be controlled to be off when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and light on illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables power delivery from the auxiliary outlets 111, 112 and the USB ports 232, 234 so that power may be again supplied from them after a power interruption due to excessive power draw, when the combined current draw falls from above to below the limit. Of course it should also be understood that the exemplary

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arrangements, the controller or other control circuitry that operates to avoid excessive power draw may also operate to discontinue delivery of power from the receptacles and the USB ports in circumstances where the power draw of the microwave cooking element and/or the refrigerator compressor requires the power delivery from the auxiliary outlets and USB ports be discontinued. In such exemplary arrangements, the control circuitry may operate to automatically resume the delivery of power to such receptacles and ports or in other embodiments a manual input may be required to cause the delivery of power to be reinstituted. Of course it should be understood that these approaches are exemplary and in other arrangements other approaches may be used.

FIGS. 19 and 20 show an alternative arrangement in which one USB port 234 is located above the auxiliary outlets 111, 112 and rightwardly adjacent the status LED indicator and reset button 240. In this exemplary arrangement, the current sensor 218 is configured to monitor the combined current draw from the USB port 234 and auxiliary outlets 111 and 112. The current sensor 218 is configured to limit the combined current draw from the USB port 234 and auxiliary outlets 111 and 112, to 12 amperes. Alternatively, the current sensor 218 may be configured to limit the combined current in the USB port 234 and the auxiliary outlets 111 and 112 to 13 amperes. The LED indicator and reset button 240 may be controlled to illuminate when power to the auxiliary outlets 111, 112 and the USB port 234 is available, and flash when the control circuitry causes the outlets and ports to be disabled. In another exemplary arrangement, the LED indicator and reset button 240 may be off when power to the auxiliary outlets 111, 112 and the USB port 234 is available, and illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables operation of the auxiliary outlets 111, 112 and the USB port 234 so that power may be again supplied from them after the controller discontinues the supply of power thereto when the combined current draw falls from above to below the limit. Of course as is the case with the previously described arrangement, the controller and other circuitry may be operative to also discontinue the supply of electrical power to the auxiliary receptacles and/or USB ports when power draw is required for the magnetron of the microwave or the refrigerator compressor is sensed that power delivery to other devices needs to be discontinued to limit excessive power draw. In such circumstances, the discontinuance of power to the auxiliary receptacles and USB ports may be automatically reinstated responsive to operation of the controller. Alternatively, in other arrangements, manual inputs may be required from a user to reinstitute the electrical delivery therefrom. Further in some exemplary arrangements, the controller may be configured so as to require manual inputs to reinstate electrical delivery only under circumstances where excessive power draw above the limits from the one or more auxiliary outlets or USB ports has occurred, thus requiring a manual input to reinstitute the electrical power delivery therefrom. Of course these approaches are exemplary and in other arrangements other approaches may be used. Other elements of the arrangements of FIGS. 17-20 may be similar in structure and function as the arrangements shown in FIGS. 1-11. Thus, the same reference numbers are used in describing these exemplary arrangements to indicate elements that are similar to elements or components in the arrangements shown in FIGS. 1-11.

FIG. 21 shows the rear portion 244 of the exemplary microwave oven of the arrangements shown in FIGS. 12-20.

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Refrigerator outlet 15 is shown on and accessible from the rear portion 244 of the microwave oven and is associated with the LED indicator and reset button 214, which is also provided on the rear portion 244 of the microwave oven. FIG. 22 is a similar view as FIG. 21 except that an AC electrical cord 8 for the microwave oven is shown.

In the arrangements shown in FIGS. 12-22, control models for control logic may be established for execution of executable instructions by the controller or microprocessor which is also referred to herein as at least one electrical power control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware within the control circuit 104. The exemplary models and logic flow are, in the first instance, dependent on the state of operation of the microwave oven 2. The current demands of the microwave oven 2 are generally the most significant contribution to overload. To avoid overload conditions, in exemplary arrangements power to the low power receptacles or auxiliary outlets, refrigerator receptacle, and/or USB ports is disabled during microwave operation.

FIG. 23 shows a flow chart illustrating several control models for operational scenarios. The at least one power control circuit 104 begins by determining whether the microwave oven is turned on or operating (e.g. cooking) in step 246. When the microwave oven is turned on and operating to perform cooking, the rear refrigerator outlet 15, the two auxiliary outlets 111, 112 on the front control panel 22, and the two USB ports 232, 234 on the front control panel are all turned off or disabled, so that the total draw of current for the combination microwave and refrigerator is not over 15 amperes as indicated in step 248.

When the microwave oven is not drawing cooking power and items are plugged into the two USB ports 232, 234, two auxiliary outlets 111, 112, and rear refrigerator outlet 15, then the exemplary at least one control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 2 amperes (approximately the average amperes when the refrigerator compressor is running) in step 250. If the refrigerator outlet 15 is drawing less than 2 amperes, then all the outlets 15, 111, 112 and USB ports 232, 234 are caused to be enabled, so that power may be supplied through them as indicated in step 252. If the refrigerator outlet 15 not drawing less than 2 amperes, the at least one control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 254. If the refrigerator outlet 15 is drawing less than 14 amperes but not less than or greater than or equal to 2 amperes, then the auxiliary outlets 111, 112 and USB ports 232, 234 are disabled or turned off so that no power may be supplied from them as indicated in step 256. The refrigerator outlet 15 remains enabled. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 is disabled in step 258. This may be accomplished by tripping the relay 20 of the reset circuit off. In addition, the red LED light on the LED indicator and reset button 214 is turned on to identify the disabled condition of the refrigerator. Then, in step 260, the auxiliary outlets 111, 112 and USB ports 232, 234 are enabled so that power may be supplied through them.

Then, the exemplary at least one control circuit determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 262. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 remains disabled and the red LED light on the LED indicator and reset button 214 remains turned on to identify the disabled

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condition of the refrigerator 3. This condition may occur, for example, if an electrical heater is plugged into what is normally used as the refrigerator electrical supply outlet 15. When the refrigerator outlet 15 draws less than 14 amperes resulting from the overload condition being eliminated, the refrigerator outlet 15 will be enabled by the control circuit so that power may be supplied to the refrigerator outlet 15 upon the LED indicator and reset button 214 being depressed as indicated in step 264. Depression of the LED indicator and reset button 214 in this condition will also turn off the red LED light. The process then ends. It should be noted that the at least one control circuit 104 can make the determination in steps at the same time or in a different order.

It should be understood that in exemplary arrangements, determination as to the power draw from receptacles that have been disabled, may be determined through a process of again supplying power output through the receptacle. The power draw from the receptacle is monitored continuously after the power is restored and if it is detected that the power draw exceeds a threshold or other determined amount, power is discontinued to the receptacle. In some exemplary arrangements, the power sensing circuitry may operate in conjunction with the controller to calculate the current power draw level. The control circuitry may also operate in accordance with its programming to determine that other connected devices are consuming power which may necessitate not providing power to the receptacle so as to avoid an overload condition. Alternatively or in addition, the control circuitry may be operative to monitor other conditions that may be indicative of a problem when the power is restored to a receptacle, port or other control outlet. For example, responsive to a manual input to reinstitute the supply of power thereto, the control circuitry may operate to recognize conditions that correspond to an electrical short or other malfunction which necessitates an immediate withdrawal of electrical power thereto. This may include, for example, monitoring the rate at which power is drawn and the current flow increases to detect a short or other fault condition. Numerous different types of detection circuitry and control approaches may be implemented in order to help assure that if power output has been discontinued, that excessive power draw or undesirable conditions are not a problem when power is reinstated.

Although exemplary arrangements are described herein as used in conjunction with vapor compression refrigerators, embodiments employing the principles described herein may also be used with other types of refrigerators. Such refrigerators may include refrigerators that use thermoelectric cooling, such as Peltier elements to provide cooling. Other arrangements may include absorption refrigerators to provide cooling. In such arrangements the components of the refrigerator apparatus which draw electrical power, are controlled through operation of at least one power control circuit, to prevent, suspend or defer the operation thereof at times when the microwave radiation emitting cooking element of other components that draw electrical power are to be operated, so as to avoid exceeding a maximum threshold for current draw for the combined appliance that is permitted by the at least one control circuit.

It should be understood that the above description is only illustrative of the exemplary arrangements. Various alternatives and modifications can be devised by those skilled in the art without departing from the teachings of exemplary arrangements. Accordingly, the present application is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

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Thus the exemplary systems, arrangements, and methods of operation that have been described herein achieve desirable capabilities, eliminate difficulties encountered in the use of prior devices and systems and attain the useful results described herein.

In the foregoing description, certain terms have been used in describing exemplary arrangements for purposes of brevity, clarity and understanding. However, no unnecessary limitations are to be implied therefrom because such terms are used for descriptive purposes and are intended to be broadly construed. Moreover, the descriptions and illustrations herein are by way of examples and the inventive features are not limited to the particular features shown and described.

Further it should be understood that elements, features, relationships, devices and other aspects described in connection with one exemplary arrangement may be utilized in connection with other exemplary arrangements such that numerous different arrangements, functions and capabilities may be carried out. Numerous different aspects of described arrangements may be used together or in different combinations to achieve useful results.

Having described the features, discoveries and principles of the exemplary arrangements, the manner in which they are constructed and operated, and the advantages and useful results attained, the new and useful structures, devices, elements, arrangements, parts, combinations, systems, equipment, operations, methods, processes and relationships are set forth in the appended claims.

We claim:

1. Apparatus comprising:

an appliance including

a microwave oven,

a refrigerator, wherein the refrigerator is in fixed operative mechanical connection with the microwave oven,

at least one power control circuit, wherein the at least one power control circuit is in operative electrical connection with the microwave oven and the refrigerator,

a single power cord, wherein the single power cord is configured to be releasably connected to a source of electrical power, wherein the at least one power control circuit is supplied with electrical power only through the single power cord,

wherein the microwave oven includes a smoke sensor, wherein the smoke sensor

is positioned in operative connection with a cooking area inside the microwave oven,

is in operative connection with the at least one power control circuit,

wherein responsive at least in part to a level of smoke sensed by the smoke sensor, the at least one power control circuit is operative to cause cooking power to the microwave oven to be withdrawn to end a cooking session prior to a set end time of the current cooking session,

wherein after the end of the current cooking session prior to the set end time based on the sensed level of smoke, the at least one control circuit is operative thereafter to enable the microwave oven to receive cooking power in a next subsequent cooking session,

wherein the at least one power control circuit is operative to

withhold electrical power from at least one component of the refrigerator when the microwave oven draws cooking power, and

deliver electrical power to the refrigerator when the microwave oven does not draw cooking power.

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2. The apparatus according to claim 1, and further comprising:
 a safe, wherein the safe is in fixed operative mechanical connection with at least one of the refrigerator and the microwave oven. 5
3. The apparatus according to claim 2
 wherein the at least one power control circuit is in operative electrical connection with the safe,
 wherein the at least one power control circuit is operative to withhold electrical power from the safe when the microwave oven draws cooking power. 10
4. The apparatus according to claim 3
 wherein the safe includes
 a safe body, wherein the safe body bounds a safe interior area, wherein the safe interior area is externally accessible through a safe opening, 15
 a safe door, wherein the safe door is movably mounted in operative supported connection with the safe body, wherein the safe door is movable between a closed position in which the safe door closes the safe opening and an open position in which the safe door is at least partially disposed away from the safe opening, 20
 a lock, wherein the lock is changeable responsive to at least one electrical signal between a locked condition and an unlocked condition, wherein in the closed position of the safe door the lock in the locked condition is operative to prevent the safe door from being moved to the open position, 25
 wherein the microwave oven includes at least one user input device configured to receive manual inputs from users, 30
 wherein the microwave oven is operable to provide cooking power usable to cook items in the cooking area responsive at least in part to inputs through the at least one user input device, 35
 wherein the at least one user input device is in operative connection with the lock,
 wherein the lock is enabled to be changed from the locked condition to the unlocked condition responsive at least in part to at least one input to the at least one user input device. 40
5. The apparatus according to claim 4
 wherein the safe further includes
 at least one safe circuit, wherein the at least one safe circuit is in operative electrical connection with the at least one power control circuit, 45
 a battery, wherein the battery is in operative connection with the at least one safe circuit,
 an audible alarm, wherein the audible alarm is in operative connection with the at least one safe circuit, 50
 at least one tamper sensor, wherein the at least one tamper sensor is operative to sense at least one safe tamper condition,
 wherein the at least one safe circuit is operative responsive at least in part to a sensed safe tamper condition sensed by the at least one tamper sensor to cause the audible alarm to output an audible signal. 55
6. The apparatus according to claim 5
 wherein the at least one tamper sensor includes at least one of 60
 at least one conductive material mesh that extends adjacent to at least a portion of the safe interior area, wherein the at least one safe circuit is operative to detect a change in integrity of the material mesh which corresponds to the sensed safe tamper condition, or 65

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- at least one conductive trace that extends in at least one of the safe walls or in the safe door, wherein the at least one safe circuit is operative to detect a break in electrical continuity of the at least one conductive trace which corresponds to the sensed safe tamper condition.
7. The apparatus according to claim 6
 wherein the at least one tamper sensor includes at least one position sensor, wherein the at least one position sensor is operative to sense relative displacement of at least one of
 the safe body relative to at least one of the refrigerator and the microwave oven, or
 the safe door relative to the safe body.
8. The apparatus according to claim 7
 wherein the at least one safe circuit is configured to cause the alarm to provide the audible signal responsive to the at least one tamper sensor sensing the sensed safe tamper condition using power from the battery when the at least one power control circuit does not supply electrical power to the at least one safe circuit.
9. The apparatus according to claim 8
 and further including
 at least one bracket, wherein the at least one bracket is in fixed operative mechanical connection with at least two of the microwave oven, the safe and the refrigerator.
10. The apparatus according to claim 9
 wherein the safe is in fixed operative mechanical engagement with at least one of the refrigerator, the microwave oven and the at least one bracket through at least one releasable fastener, wherein the at least one releasable fastener is accessible to be released only from within the safe interior area.
11. The apparatus according to claim 9 and further including
 a power connector that is usable to charge a battery of a mobile device,
 wherein the power connector is in operative connection with the at least one power control circuit,
 wherein the power connector is positioned to be connected to the mobile device in the safe interior area.
12. Apparatus comprising:
 an appliance including
 a microwave oven,
 a refrigerator,
 a safe,
 wherein the microwave oven, the refrigerator and the safe are in fixed operative mechanical connection,
 at least one power control circuit, wherein the at least one power control circuit selectively supplies electrical power to at least two of the microwave oven, the refrigerator and the safe.
13. The apparatus according to claim 12
 and further including a single power cord, wherein the single power cord is configured to be releasably connected to a source of electrical power, wherein the at least one power control circuit is supplied with electrical power only through the single power cord.
14. The apparatus according to claim 13
 wherein the safe includes
 a safe body, wherein the safe body bounds a safe interior area, wherein the safe interior area is externally accessible through a safe opening,
 a safe door, wherein the safe door is movably mounted in operative supported connection with the safe body, wherein the safe door is movable between a closed position in which the safe door closes the safe 265

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opening and an open position in which the safe door is at least partially disposed away from the safe opening,

a lock, wherein the lock is changeable between a locked condition and an unlocked condition, wherein in the closed position of the safe door and the lock in the locked condition, the lock is operative to prevent the safe door from being moved to the open position.

15. The apparatus according to claim 14 wherein the at least one power control circuit is operative to selectively supply and withhold electrical power from the single power cord to each of the microwave oven, the refrigerator and the safe.

16. The apparatus according to claim 15 wherein the microwave oven includes at least one user input device configured to receive manual inputs from users,

wherein the microwave oven is operable to provide cooking power usable to cook items in a cooking area of the microwave oven responsive at least in part to inputs through the at least one user input device,

wherein the at least one user input device is in operative connection with the lock,

wherein the lock is enabled to be changed from the locked condition to the unlocked condition responsive at least in part to at least one input to the at least one user input device.

17. The apparatus according to claim 16 wherein the safe further includes

at least one safe circuit, wherein the at least one safe circuit is in operative electrical connection with the at least one power control circuit,

a battery, wherein the battery is in operative connection with the at least one safe circuit,

an audible alarm, wherein the audible alarm is in operative connection with the at least one safe circuit,

at least one tamper sensor, wherein the at least one tamper sensor is operative to sense at least one safe tamper condition,

wherein the at least one safe circuit is operative responsive at least in part to a sensed safe tamper condition sensed by the at least one tamper sensor to cause the audible alarm output an audible signal.

18. The apparatus according to claim 17 wherein the at least one safe circuit is configured to cause the alarm to provide the audible signal responsive at least in part to the sensed safe tamper condition by the at least one tamper sensor using power from the battery when the at least one power control circuit does not supply electrical power to the at least one safe circuit.

19. The apparatus according to claim 18 a power connector that is usable to charge a battery of a mobile device,

wherein the power connector is in operative connection with the at least one power control circuit,

wherein the power connector is positioned to be connectable to the mobile device in the safe interior area.

20. The apparatus according to claim 19 wherein the microwave oven includes a smoke sensor, wherein the smoke sensor is positioned in operative connection with the cooking area inside the microwave oven,

wherein the smoke sensor is in operative connection with the at least one power control circuit,

wherein responsive at least in part to a level of smoke sensed by the smoke sensor, the at least one power

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control circuit is operative to cause cooking power to the microwave oven to be withdrawn to end a current cooking session prior to a set end time of the current cooking session,

wherein after the end of the current cooking session prior to the set end time due to the sensed level of smoke, the at least one control circuit is operative thereafter to enable the microwave oven to receive cooking power in a next subsequent cooking session.

wherein the at least one power control circuit is operative to withhold electrical power from the refrigerator when the microwave oven draws cooking power, and deliver electrical power to the refrigerator when the microwave oven does not draw cooking power.

21. Apparatus comprising:

an appliance including

at least one electrical power control circuit,

a microwave oven, wherein the microwave oven is in operative electrical connection with the at least one electrical power control circuit,

wherein the microwave oven includes an interior cooking area,

a smoke sensor, wherein the smoke sensor is positioned in operative connection with the cooking area,

wherein the smoke sensor is in operative connection with the at least one electrical power control circuit and is configured to cause cooking power to be withdrawn from the microwave oven prior to a set end time of a current cooking session responsive at least in part to the smoke sensor sensing an amount of smoke,

wherein the at least one electrical power control circuit is configured such that after ending the current cooking session prior to the set end time due to sensing the amount of smoke, to enable cooking power to again be available to the microwave oven in a next subsequent cooking session,

a refrigerator, wherein the refrigerator is in operative electrical connection with the at least one electrical power control circuit,

wherein the refrigerator includes a plurality of electrically powered refrigerator components,

wherein the at least one electrical power control circuit is operative to cause electrical power to be unavailable to at least one electrically powered refrigerator component when the microwave oven is operative to draw cooking power, and electrical power to be available to the at least one electrically powered refrigerator component when the microwave oven does not draw cooking power.

22. The apparatus according to claim 21 and further comprising:

a safe, wherein the safe is in fixed operative mechanical connection with at least one of the refrigerator and the microwave oven.

23. The apparatus according to claim 22 wherein the safe includes at least one of

a lock, wherein the lock is electrically changeable between a locked condition and an unlocked condition, and wherein the lock is in operative electrical connection with the at least one electrical power control circuit,

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a power connector configured to charge a battery of a mobile device, wherein the power connector is in operative electrical connection with the at least one electrical power control circuit.

24. The apparatus according to claim 23

wherein the safe includes the lock, wherein in the locked condition the lock is operative to hold a safe door of the safe in a closed position,

wherein the microwave oven includes at least one user input device configured to receive manual inputs from users,

wherein the at least one user input device is in operative connection with the lock,

wherein the lock is enabled to be changed from the locked condition to the unlocked condition responsive at least in part to at least one input to the at least one user input device.

25. The apparatus according to claim 21

wherein the microwave oven includes a USB port, wherein the USB port is in operative connection with the at least one electrical power control circuit,

wherein the USB port is not operative to deliver electrical power from the USB port when the microwave oven is operative to draw cooking power.

26. The apparatus according claim 21, wherein the microwave oven further includes at least one output device including at least one of

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a USB port,

an inductance charging pad, and

an auxiliary electrical outlet,

wherein the at least one output device is in operative connection with the at least one electrical control circuit, and wherein the at least one electrical control circuit is operative to cause the at least one output device to be inoperative when the microwave oven draws cooking power.

27. The apparatus according to claim 21 and further including

a wireless interface, wherein the wireless interface is in operative connection with the at least one electrical power control circuit,

wherein the wireless interface is operative to transmit signals indicative of a condition of at least one of the microwave oven and the refrigerator, to a wireless mobile device.

28. The apparatus according to claim 21, wherein the smoke sensor includes at least one of

a radiation emitter and radiation receiver,

a photosensor,

a motion sensor,

an ionization sensor, and

a VOC sensor.

* * * * *

EXHIBIT
US Patent No. 10, 9 , 7



US010495374B1

(12) **United States Patent**
Hall et al.

(10) **Patent No.:** **US 10,495,374 B1**
(45) **Date of Patent:** **Dec. 3, 2019**

(54) **MULTIPLE LINKED APPLIANCE WITH
AUXILIARY OUTLET**

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(US)

(73) Assignee: **Intirion Corporation**, Walpole, MA
(US)

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(22) Filed: **May 19, 2017**

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continuation-in-part of application No. 14/262,290,
filed on Apr. 25, 2014, now Pat. No. 9,657,974, which
is a continuation-in-part of application No.
12/317,632, filed on Dec. 23, 2008, now Pat. No.
8,742,304.

(60) Provisional application No. 61/009,419, filed on Dec.
28, 2007.

(51) **Int. Cl.**
H05B 6/64 (2006.01)
H05B 6/66 (2006.01)
H05B 6/68 (2006.01)
F25D 23/12 (2006.01)

(52) **U.S. Cl.**
CPC **F25D 23/12** (2013.01); **H05B 6/666**
(2013.01); **H05B 6/68** (2013.01)

(58) **Field of Classification Search**

CPC H05B 6/645; H05B 6/666; H05B 6/68;
H05B 6/806; F25D 23/12; F25B 29/005
USPC 219/482, 483, 485, 488, 678, 679, 695,
219/697, 702, 715, 716, 717, 718, 719,
219/720, 721, 722, 723, 756, 757, 760,
219/761

See application file for complete search history.

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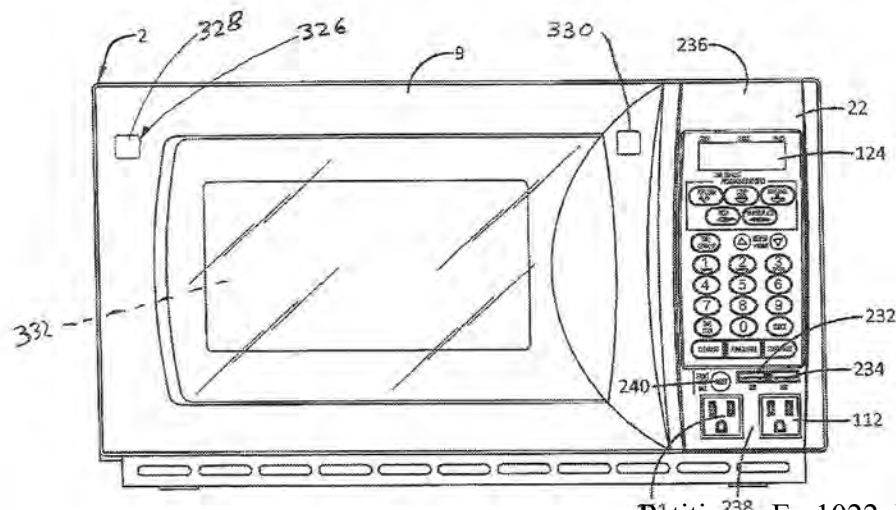
Primary Examiner — Hung D Nguyen

(74) *Attorney, Agent, or Firm* — Ralph E. Jocke; Walker
& Jocke

(57) **ABSTRACT**

A combination microwave and refrigerator system is provided. The microwave oven is connected to a source of power and has a control circuit for controlling the operation of the microwave oven. A first power supply outlet is provided on the microwave oven. A refrigerator is connected to the source of power by connection to the first power supply outlet. The control circuit is configured to disable the cooking operation of the refrigerator, when the microwave oven demands cooking power, and enable the cooling operation of the refrigerator when the microwave oven is not drawing cooking power. A safety sensor is provided in the microwave oven, and is configured to cause cooking power to the microwave oven to be turned off upon the safety sensor sensing a dangerous condition.

20 Claims, 25 Drawing Sheets



Petitioner Ex 1022, Page 137 of 265

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					219/679	

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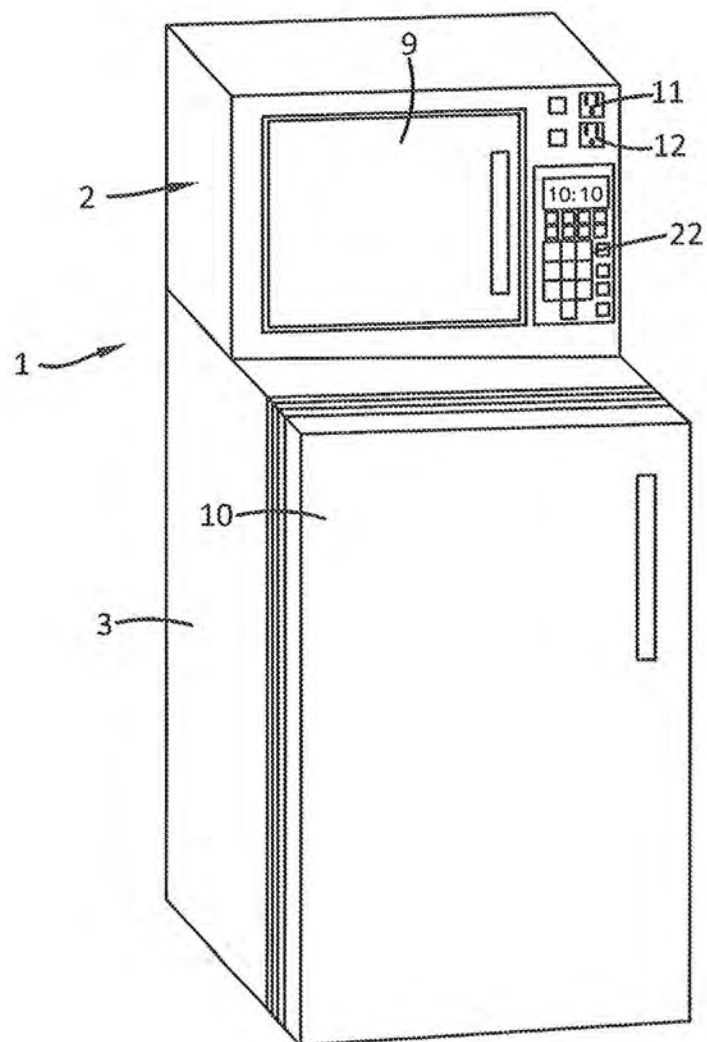


FIGURE 1

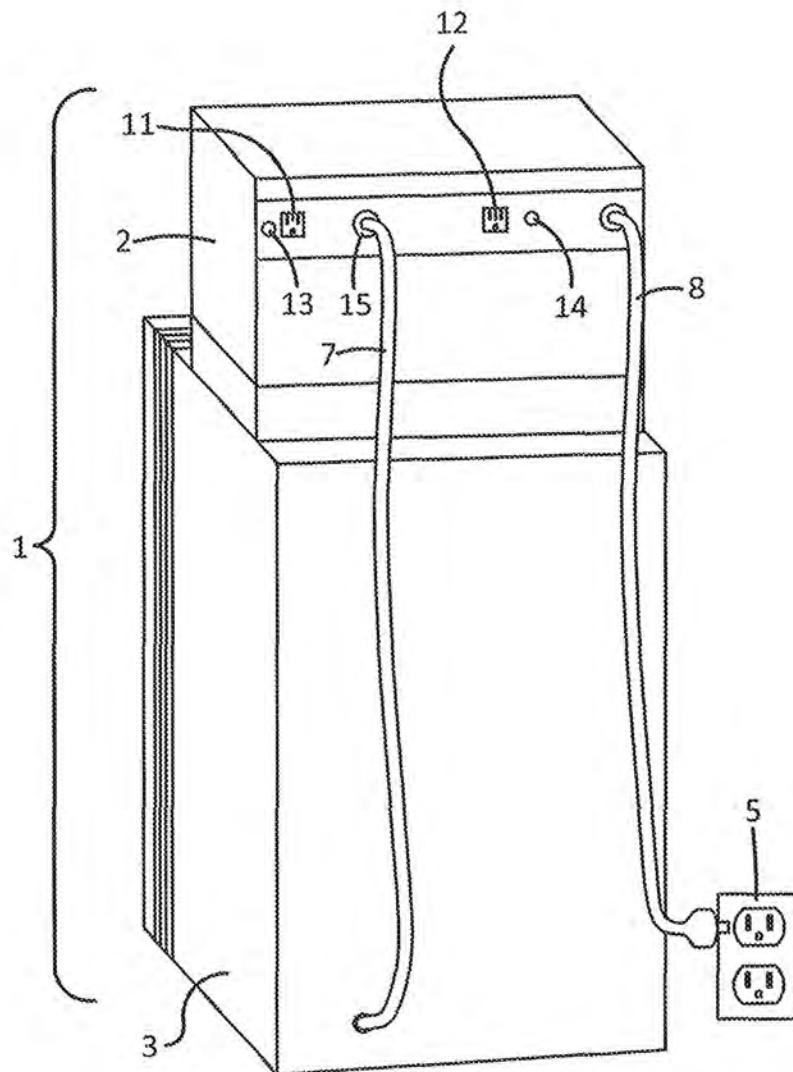


FIGURE 2

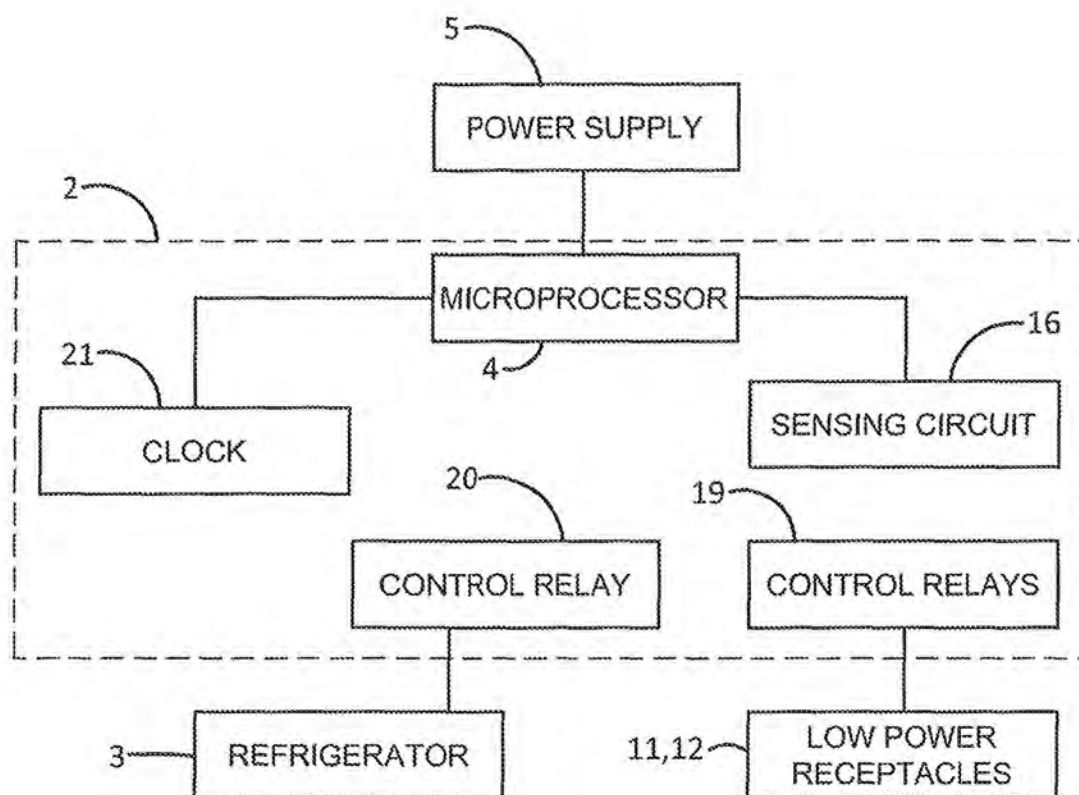


FIGURE 3

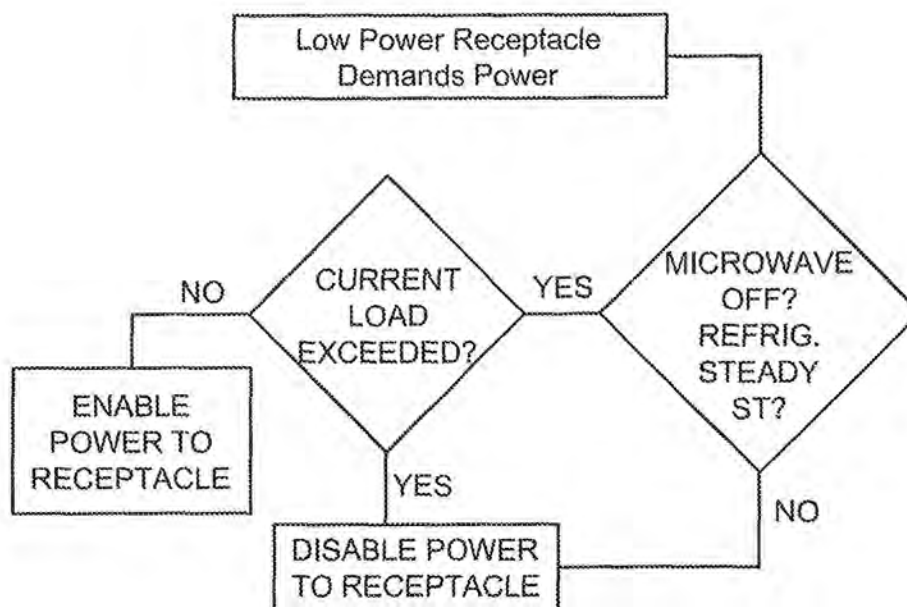


FIGURE 5

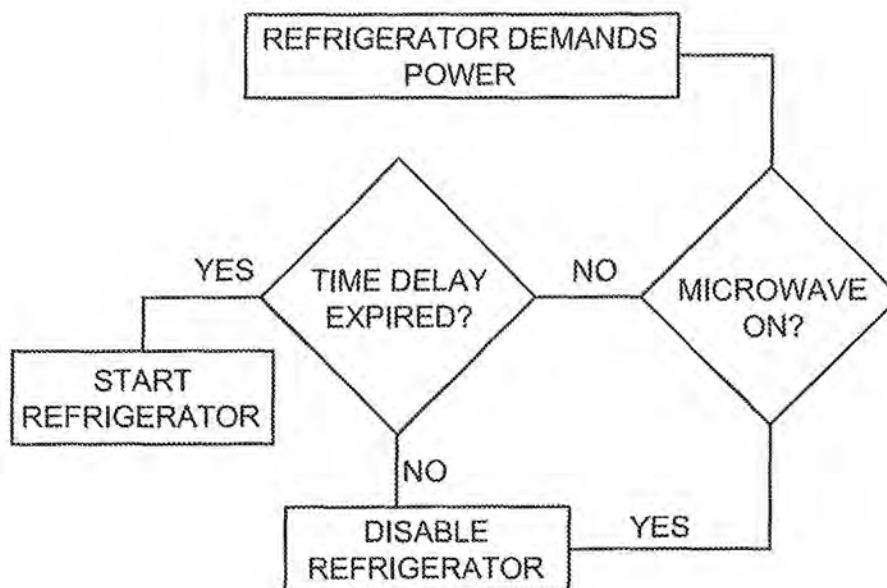


FIGURE 6

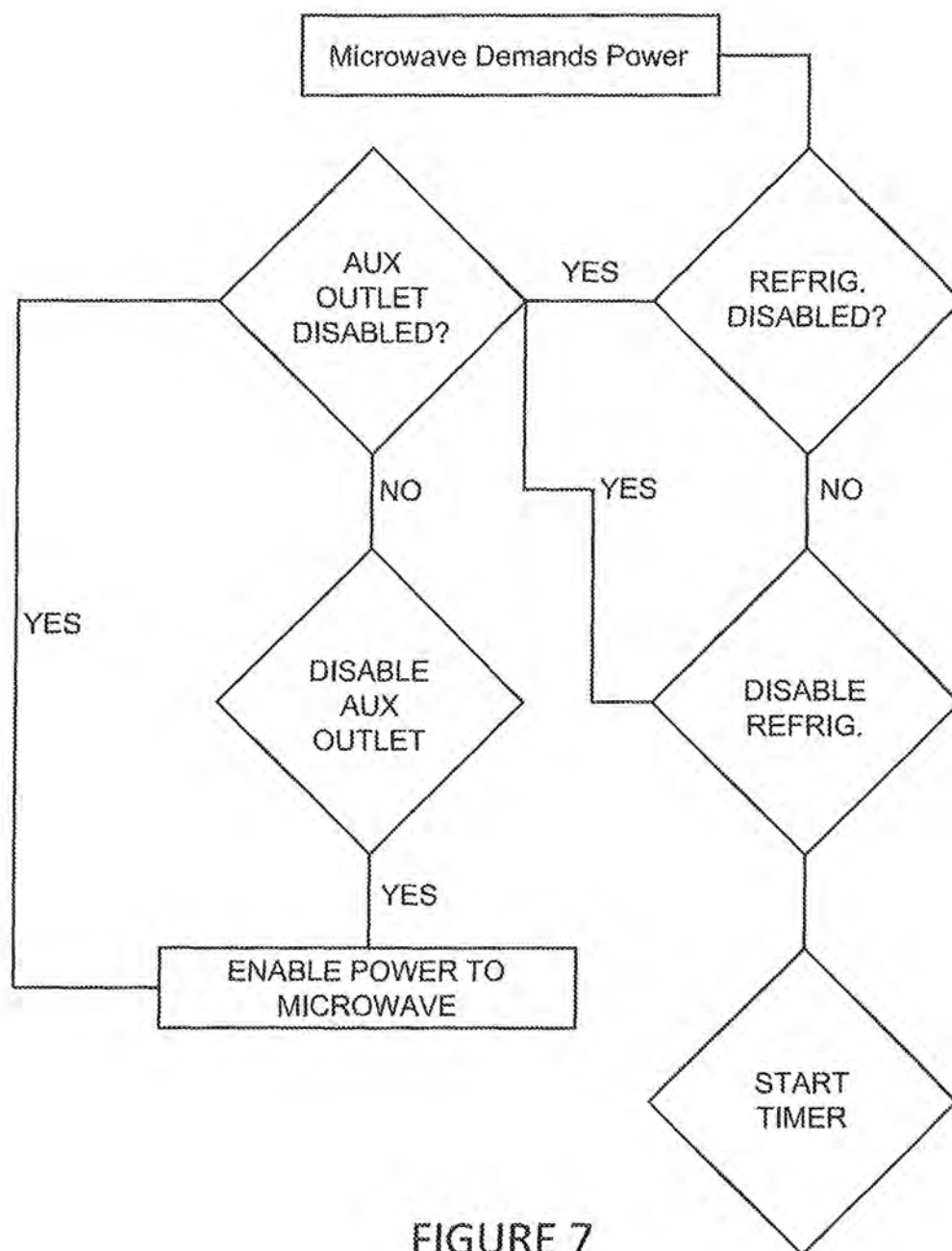


FIGURE 7

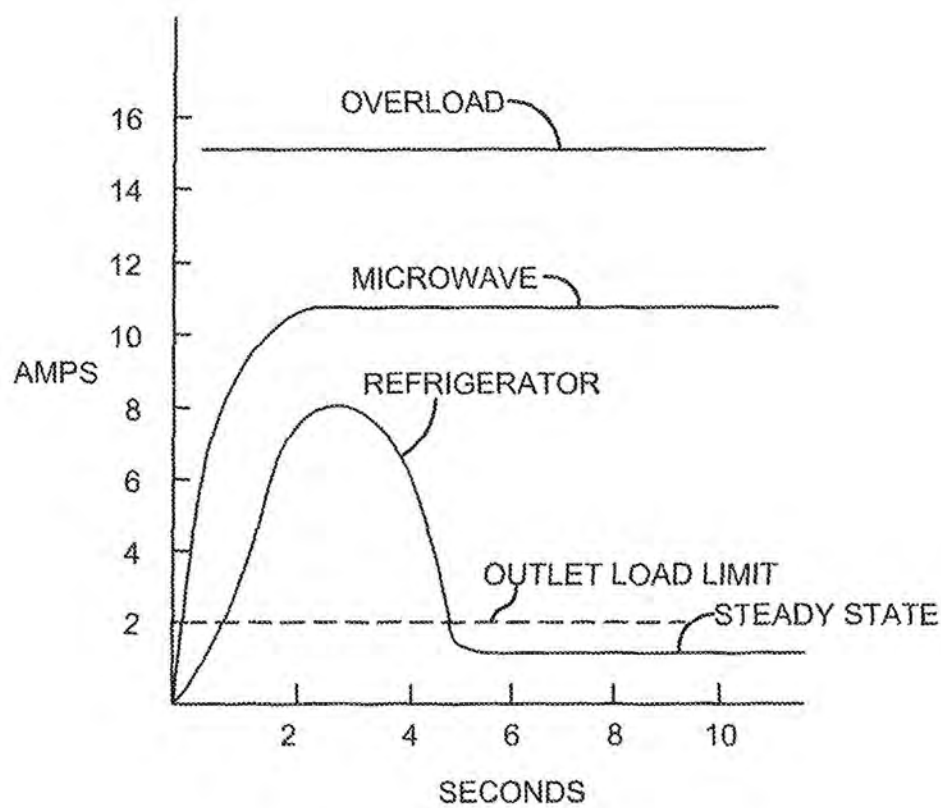


FIGURE 8

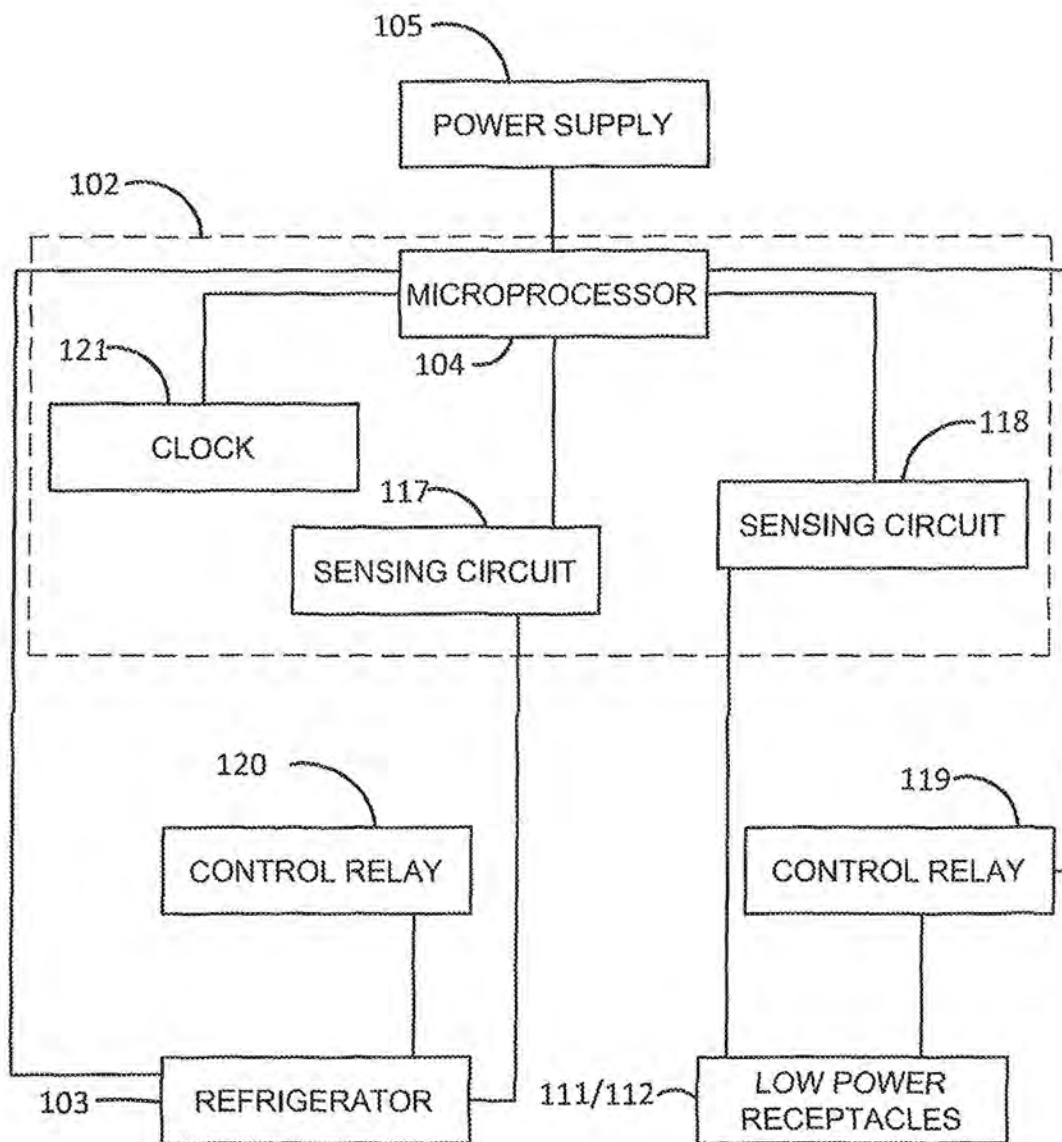


FIGURE 9

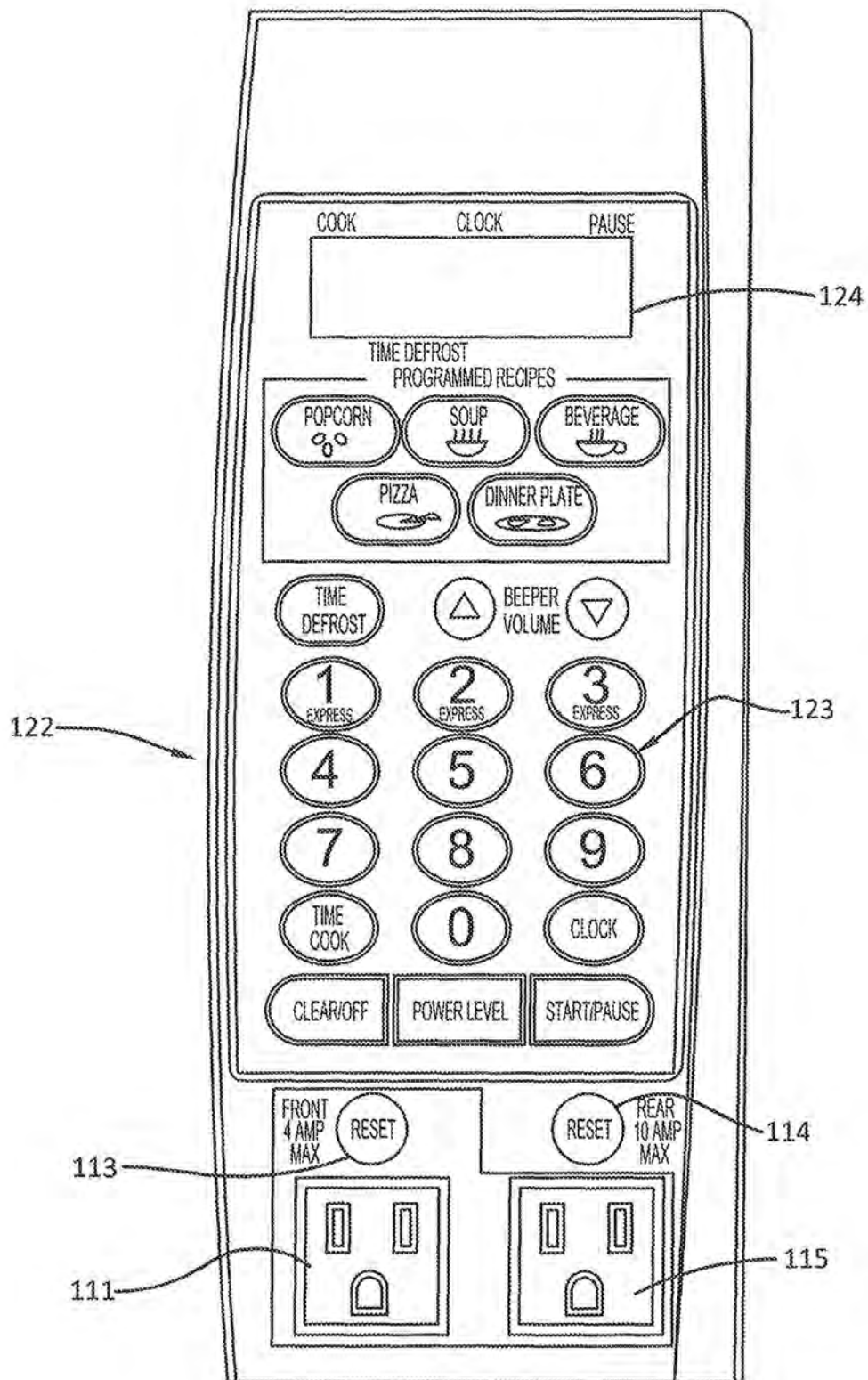


FIGURE 11

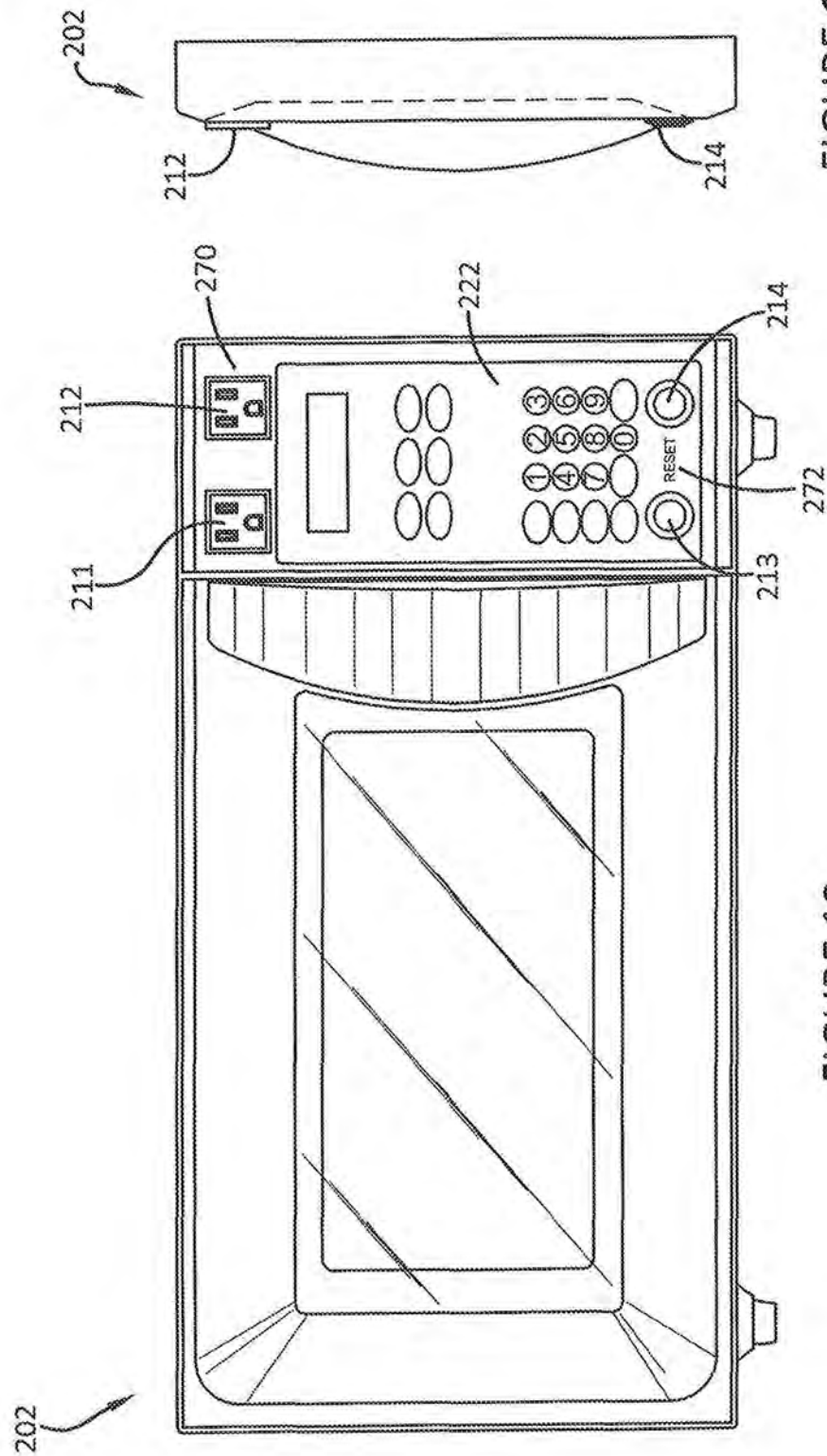


FIGURE 13

FIGURE 12

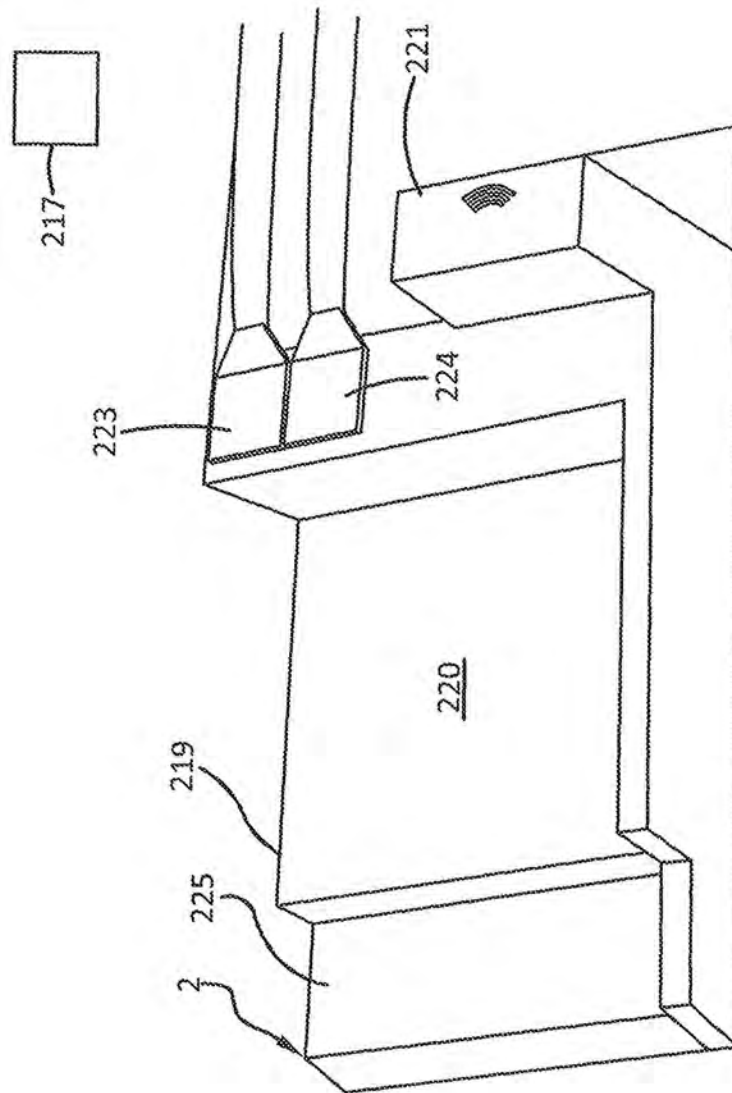
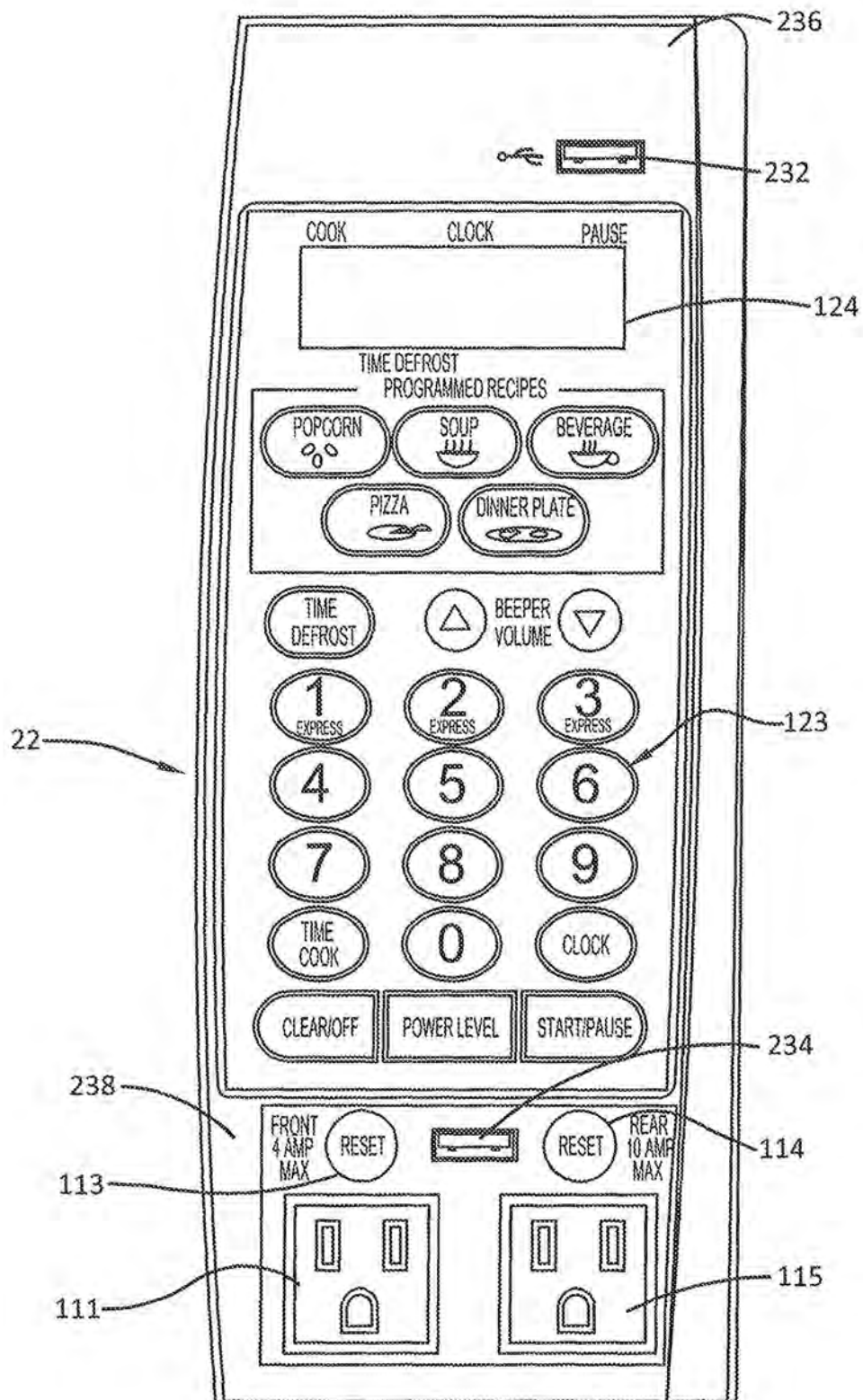
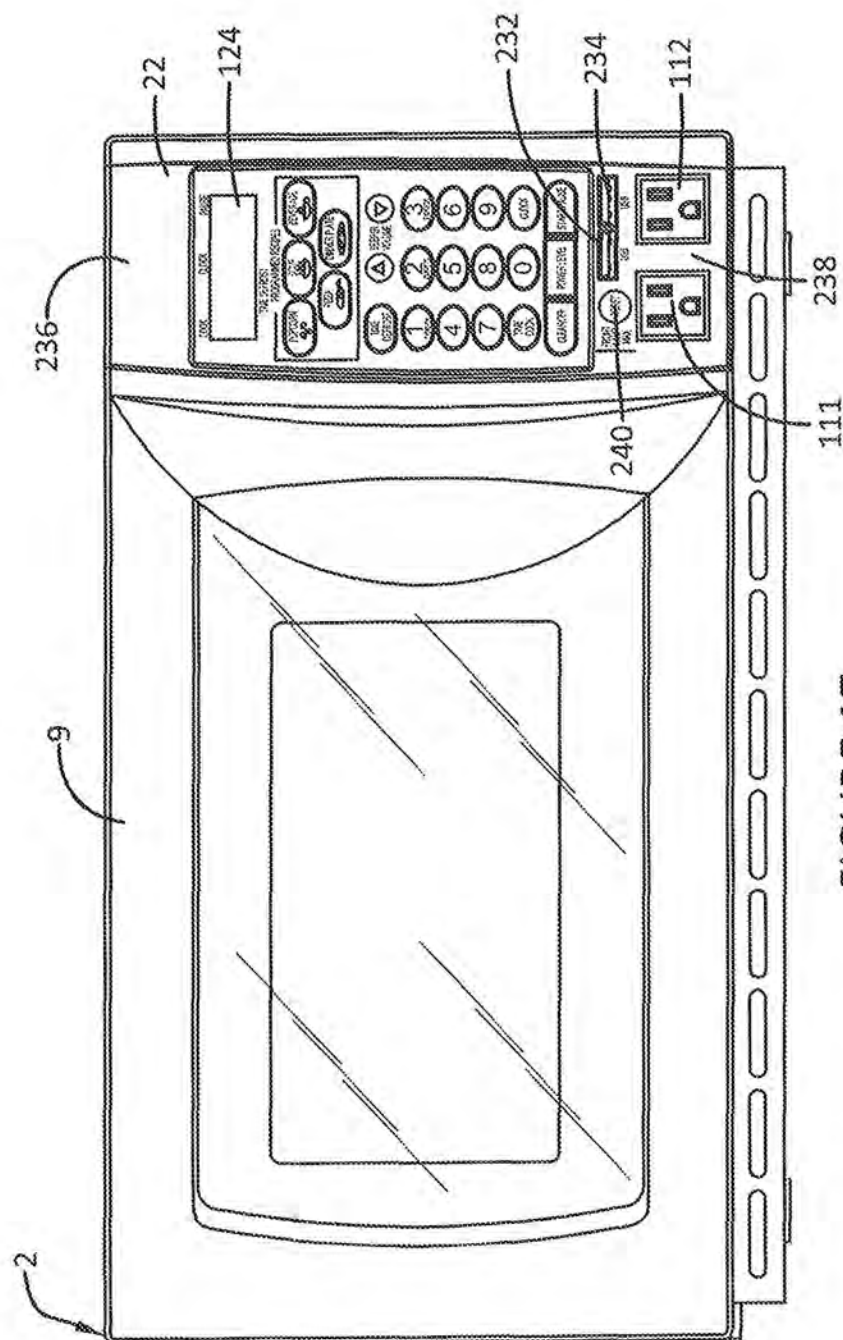


FIGURE 14





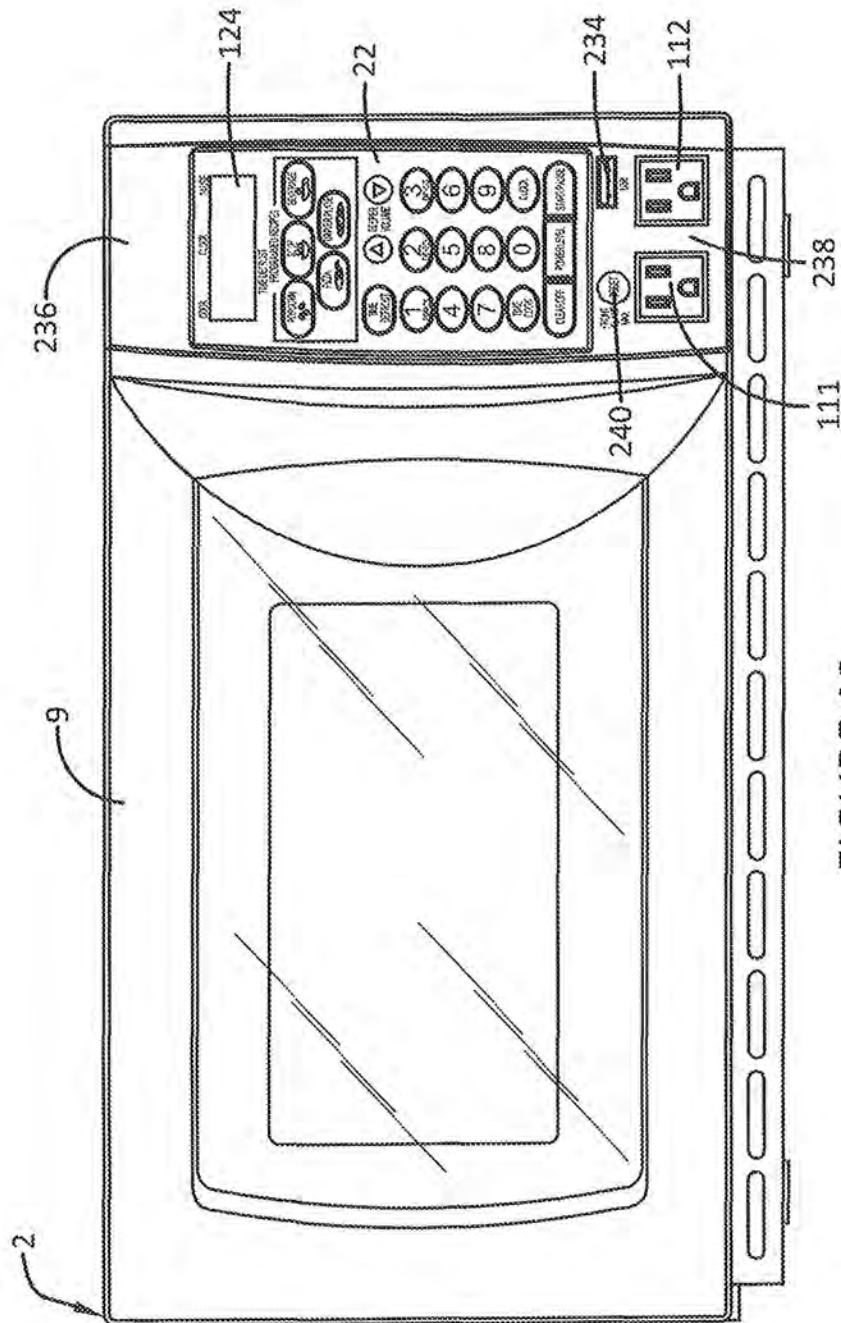
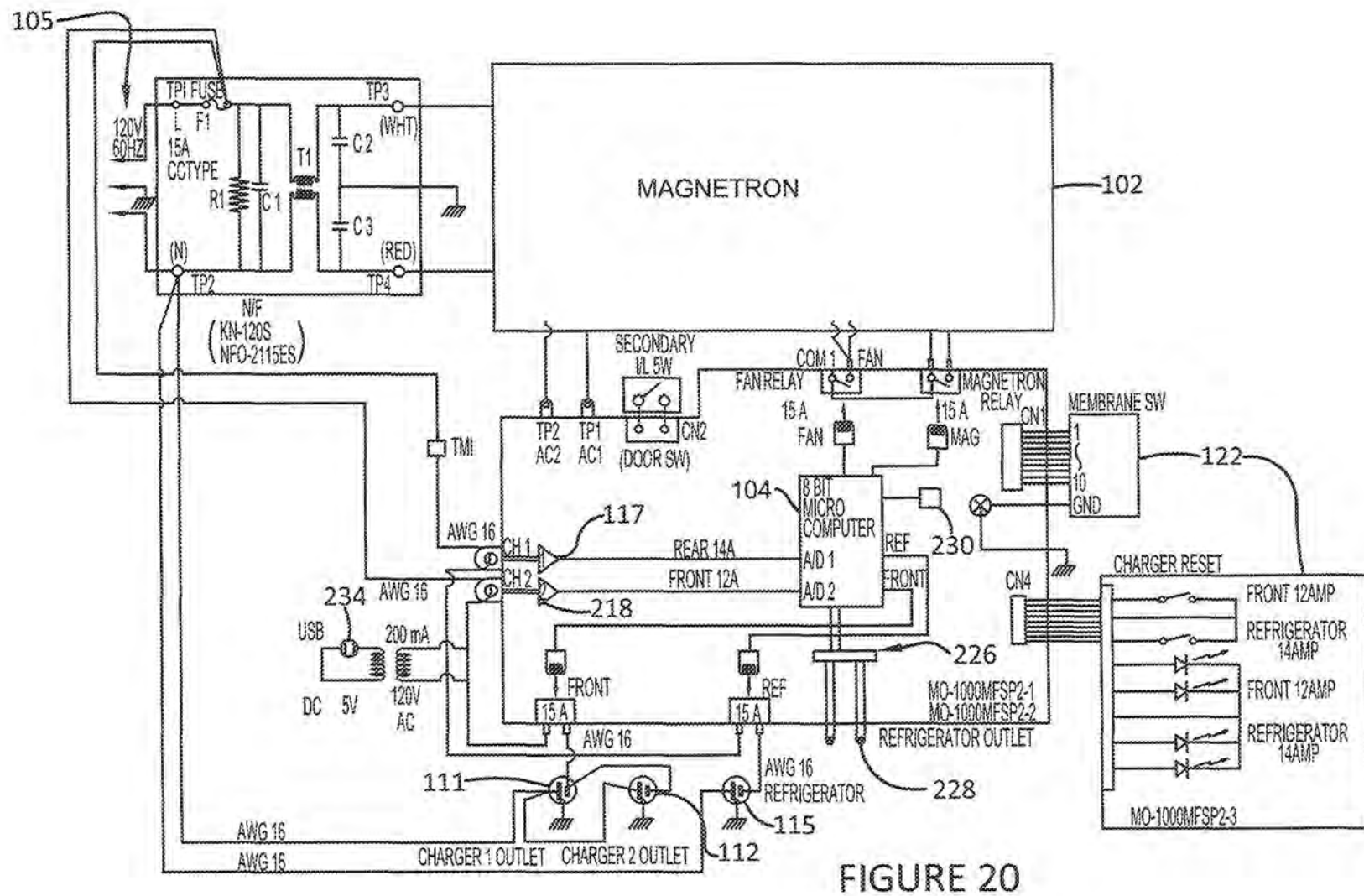


FIGURE 19



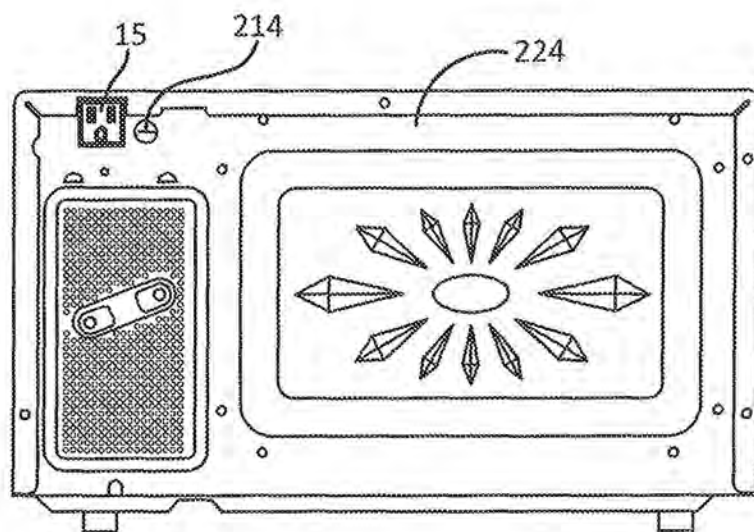


FIGURE 21

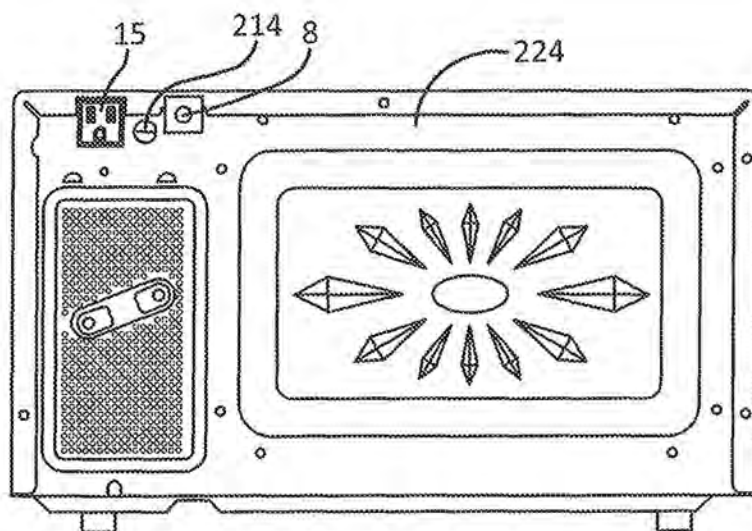


FIGURE 22

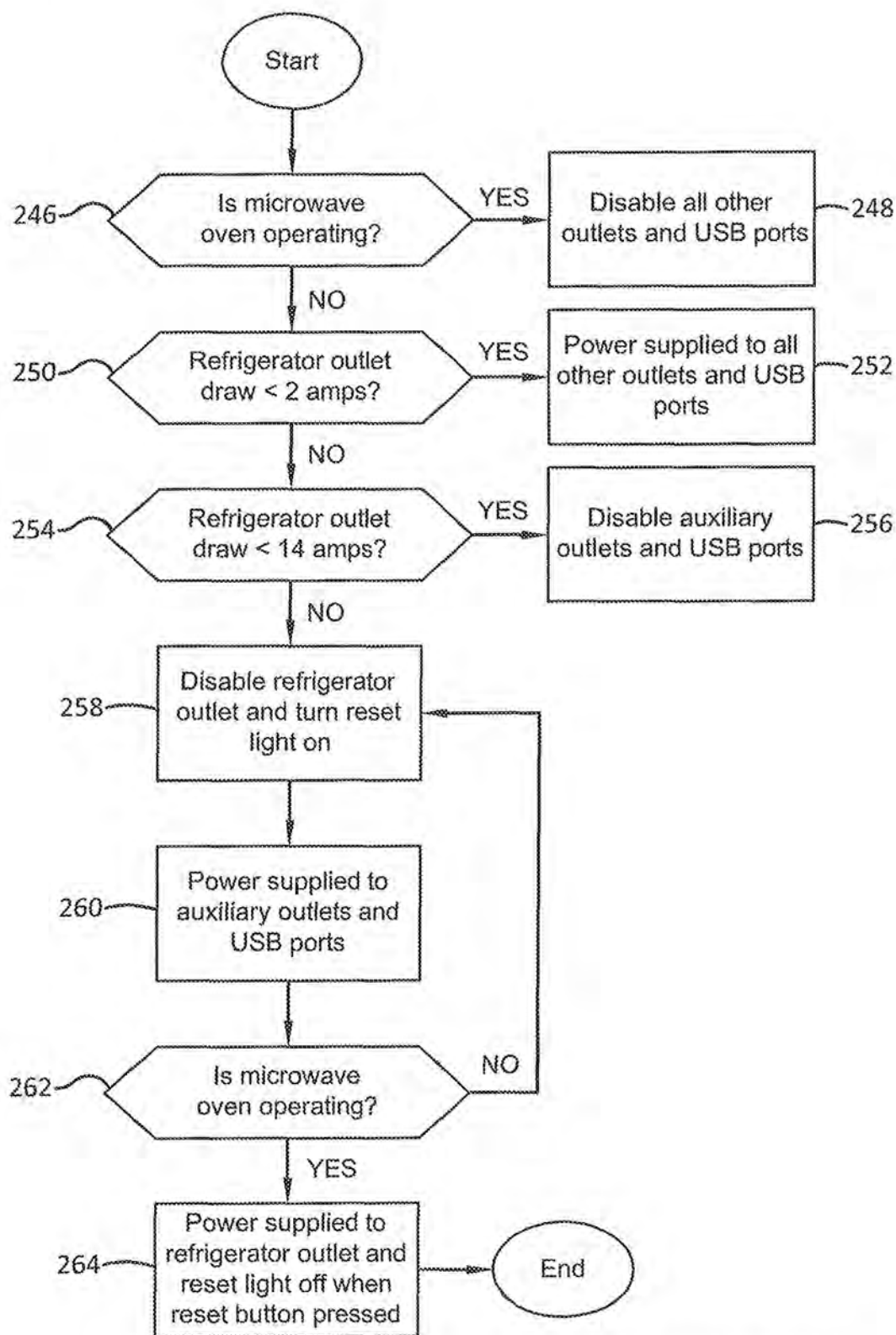
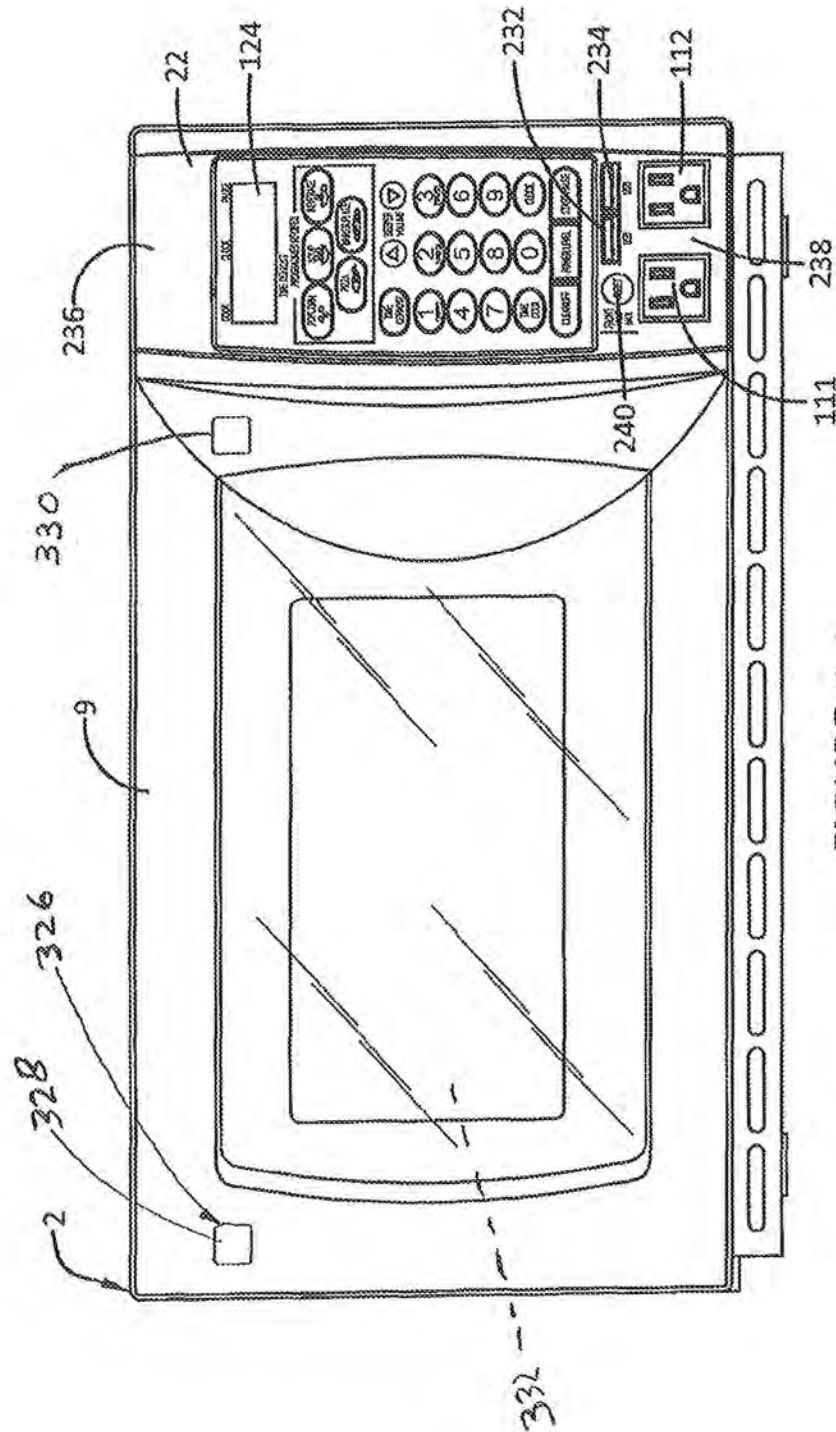


FIGURE 23



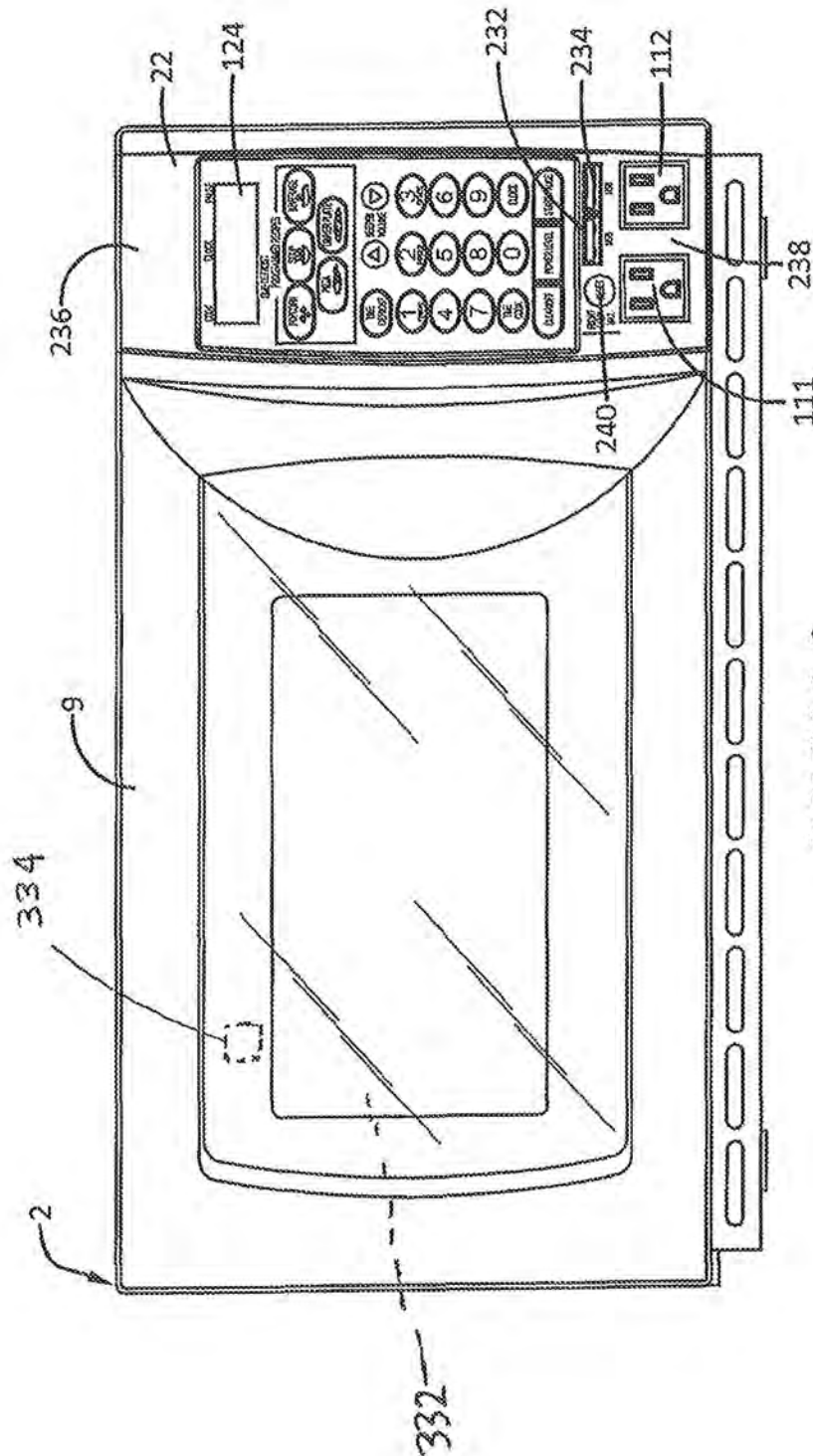


FIGURE 25

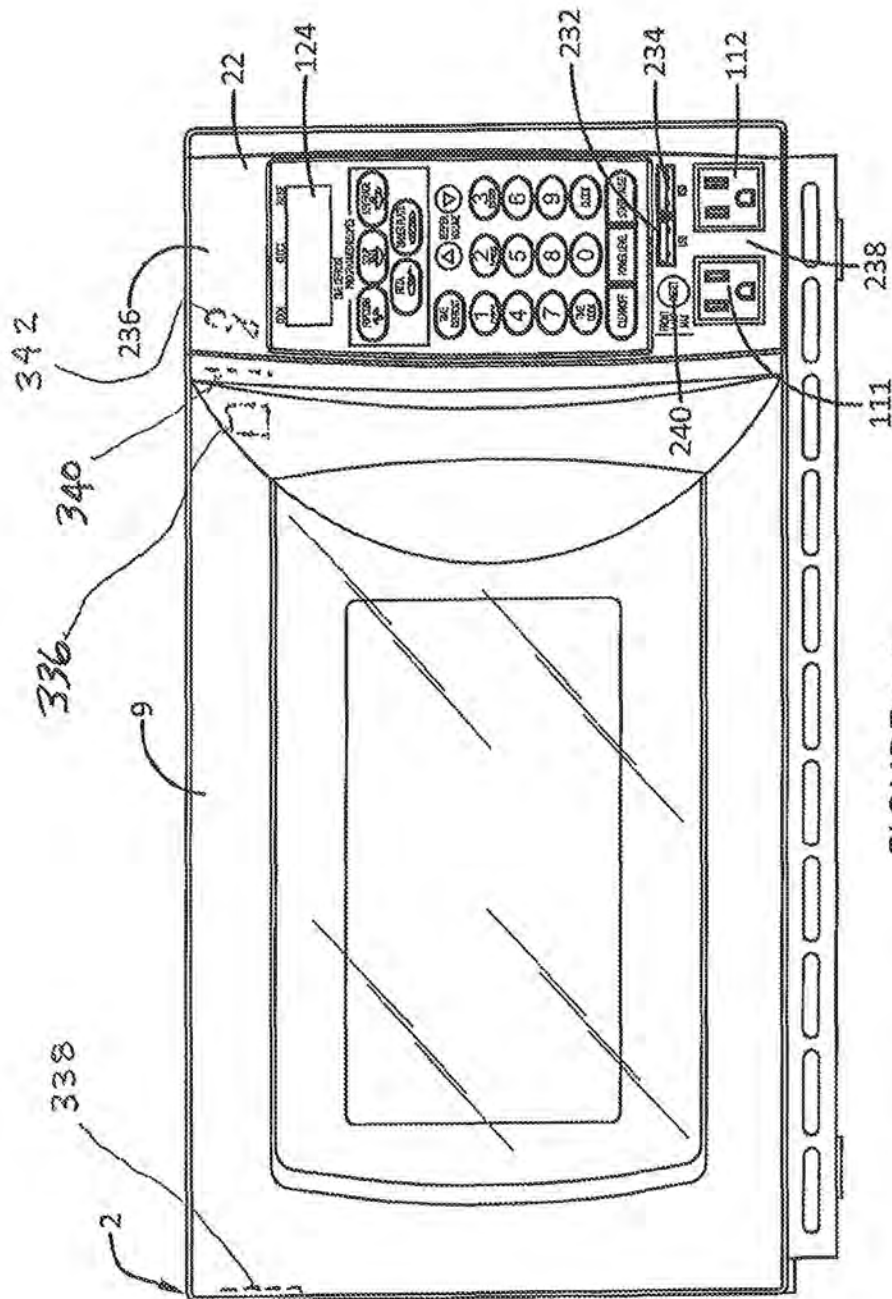


FIGURE 26

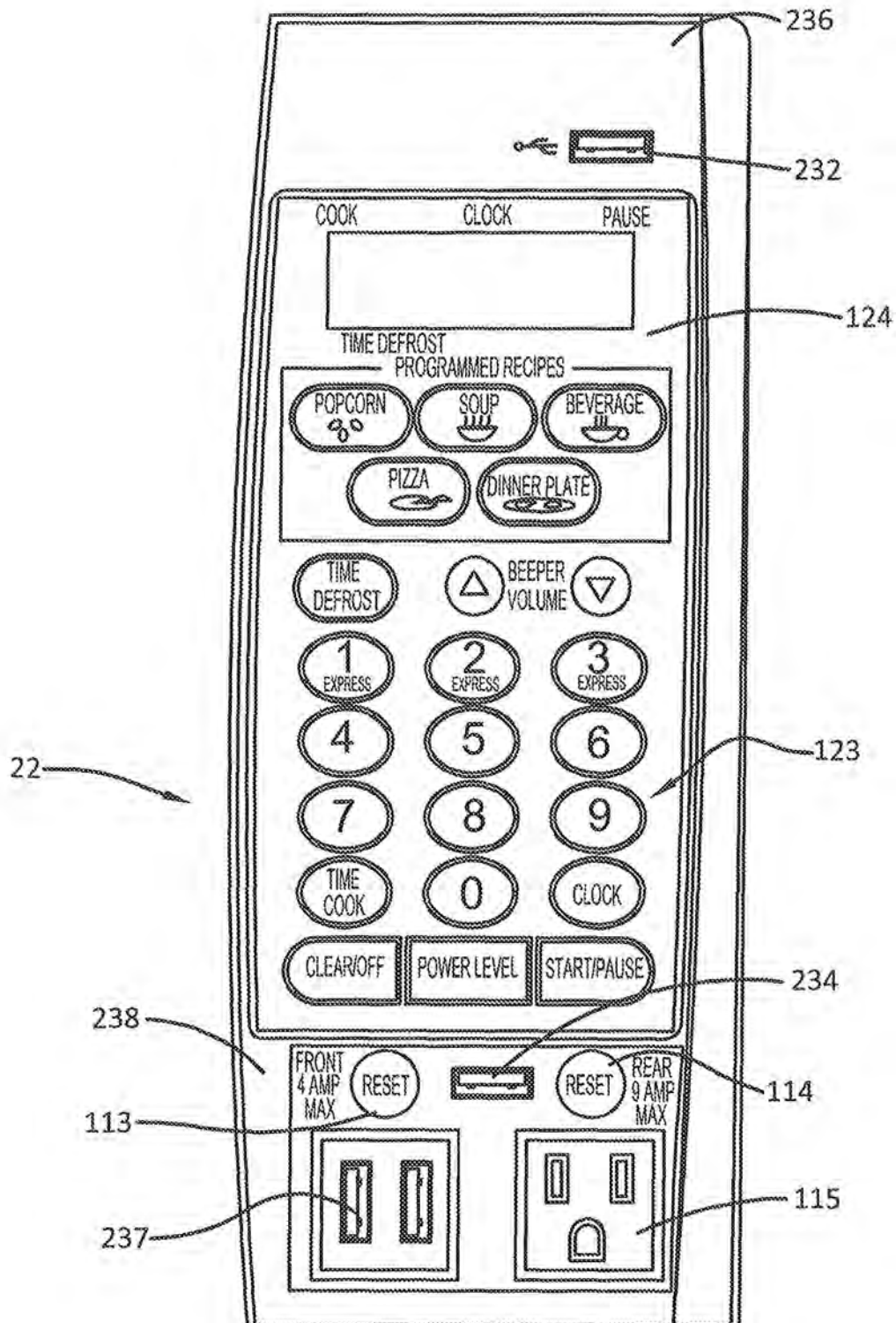


FIGURE 27

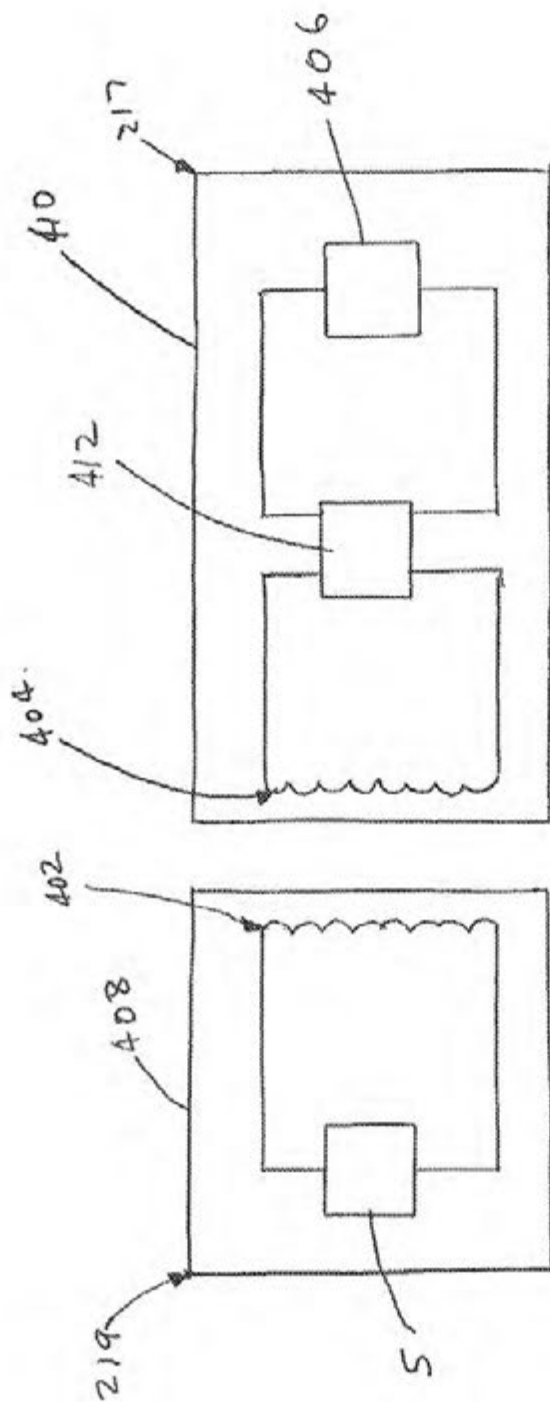


FIGURE 28

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MULTIPLE LINKED APPLIANCE WITH AUXILIARY OUTLET

TECHNICAL FIELD

Exemplary embodiments relate to improvements to appliances. Specifically, exemplary embodiments relate to improvements to appliances that include compact refrigerator and microwave oven functionality.

BACKGROUND

Compact refrigerators are used for many different purposes. They are often found in dormitories, hotels, offices and other establishments. Compact refrigerators are also often used in housing units for storage of beverages in bar areas or entertainment areas. Compact refrigerators provide useful storage for refrigerated items without the requirement for the considerable floor space and power draw that is required for a full size refrigerator.

Compact refrigerators and associated appliances may benefit from improvements.

SUMMARY

In one exemplary embodiment, an apparatus is provided that includes a microwave oven. The microwave oven includes a radiation emitting microwave element and a microwave housing. The microwave housing bounds a cooking interior area. The radiation emitting microwave element is operative to irradiate the cooking interior area. The apparatus also includes a refrigerator. The refrigerator includes refrigerator housing. The refrigerator housing bounds a cooled refrigerator interior area. The refrigerator housing is in fixed operative connection with the microwave housing. The refrigerator includes a refrigerant compressor, or other refrigeration technology. The refrigerant compressor is operative to compress a refrigerant material. The refrigerant material is operative to cause cooling of the cooled refrigerator interior area. The apparatus includes at least one power control circuit. The at least one power control circuit is operative to cause electrical power to be selectively delivered to the microwave element and the compressor. One of the microwave element and compressor does not operate when the other of the microwave element and the compressor operates. A charging pad is provided on the microwave oven. The charging pad is configured for receiving an item to be charged by the charging pad. The microwave oven further includes at least one smoke sensor. In exemplary embodiments different types of smoke sensors may be used. An exemplary sensor includes a sensor emitter and at least one sensor receiver configured to receive radiation from the at least one smoke sensor emitter, wherein air of at least a portion of the cooking interior area extends intermediate of the at least one sensor emitter and the at least one sensor receiver. The apparatus also includes at least one safety circuit. The at least one safety circuit is in operative connection with the at least one sensor emitter, the at least one sensor receiver, and the microwave element. The at least one safety circuit is operative to cause the at least one sensor emitter to emit sensor radiation and the at least one sensor receiver to sense sensor radiation from the at least one sensor emitter while the microwave element operates during a cooking session. A determination is made that a transmission amount of sensor radiation from the at least one sensor emitter that reaches the at least one sensor receiver has fallen by at least a threshold amount during the cooking session,

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due to smoke in the cooking interior area. Responsive at least in part to the determination, the microwave element is no longer supplied with electrical power. Other features may be included in exemplary embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The system of the application is explained in more detail below with reference to the accompanying drawings, in which:

FIG. 1 is a front perspective view of an exemplary embodiment of an appliance system of this application.

FIG. 2 is a rear perspective view of the embodiment of FIG. 1 showing an alternative arrangement.

FIG. 3 is a schematic block diagram of an embodiment of the exemplary system.

FIG. 4 is an electrical schematic diagram corresponding to the embodiment of FIG. 3.

FIG. 5 is a schematic logic flow diagram of an exemplary embodiment.

FIG. 6 is a schematic logic flow diagram of another exemplary embodiment.

FIG. 7 is a schematic logic flow diagram of another embodiment.

FIG. 8 is a graph illustrating the duty cycles of the appliances in the system of FIG. 3.

FIG. 9 is a block diagram of an alternate embodiment.

FIG. 10 is an electrical schematic diagram of the embodiment of FIG. 9.

FIG. 11 is an illustration of a control panel of the embodiment of FIG. 9.

FIG. 12 is a front view of the microwave oven according to another embodiment.

FIG. 13 is a side view of the microwave oven door of FIG. 12.

FIG. 14 is a top perspective view of a charging pad on the top portion of a microwave oven.

FIG. 15 is an illustration of a control panel of an alternate embodiment.

FIG. 16 is an electrical schematic diagram of the embodiment of FIG. 15.

FIG. 17 is a front view of the microwave oven according to another embodiment.

FIG. 18 is an electrical schematic diagram of the embodiment of FIG. 17.

FIG. 19 is a front view of the microwave oven according to another exemplary embodiment.

FIG. 20 is an electrical schematic diagram of the embodiment of FIG. 19.

FIG. 21 is a rear view of the microwave oven according to the embodiments of FIGS. 12-19.

FIG. 22 is a similar view as that of FIG. 21 except that the AC cord is shown.

FIG. 23 is a schematic logic flow diagram of an exemplary embodiment.

FIG. 24 is a front view of the microwave oven according to another exemplary embodiment.

FIG. 25 is a front view of the microwave oven according to another embodiment.

FIG. 26 is a front view of the microwave oven according to another exemplary embodiment.

FIG. 27 is an illustration of a control panel of an alternate embodiment.

FIG. 28 is a schematic diagram corresponding to the embodiment of FIG. 14 showing the charging pad and a device being charged.

DETAILED DESCRIPTION

A multiple linked appliance system 1, for example, a combination microwave oven 2 and refrigerator 3 incorporating features described in the present application illustrated in the Figures. Although exemplary embodiments will be described with reference to the features shown in the drawings, it should be understood that other embodiments may have many alternate forms. In addition, any suitable size, shape or type of elements or materials could be used. The computer or controller devices described in this application may be constructed having one or several processors and one or several program product modules stored in one or several memory elements. For illustration, computer or controller components may be described as individual units by function. It should be understood, that in some instances, these functional components may be separated or combined in other components.

In the exemplary embodiments, the circuits described herein may comprise one or more circuits including processors which for purposes hereof corresponds to any electronic device that is configured via circuit executable instructions that can be implemented in either hardware circuits, software, firmware or applications that are operative to enable the circuits to process data and carry out the other actions described herein. For example, the circuits may include circuits that correspond to one or more or a combination of a CPU, FPGA, ASIC or any other integrated circuit or other type or circuit that is capable of processing data. The processors may be included in a computer, server or other type of electronic device. Further, the circuits described herein may include data stores that correspond to one or more of volatile or non-volatile memories such as random access memory, flash memory, magnetic memory, optical memory, solid state memory or other devices that are operative to store computer executable instructions and data. Computer executable instructions may include instructions in any of a plurality of programming languages and formats including, without limitation, routines, subroutines, programs, threads of execution, objects, methodologies and functions which carry out the actions such as those described herein. Structures for the circuits and processors may include, correspond to and utilize the principles described in the textbook entitled *Microprocessor Architecture, Programming, and Applications with the 8085* by Ramesh S. Gaonker (Prentiss Hall, 2002), which is incorporated herein by reference in its entirety. Of course it should be understood that these circuit structures are exemplary and in other embodiments, other circuit structures for storing, processing, resolving and outputting information may be used.

In exemplary embodiments the refrigerator may be connected to a power supply that provides a connection that enables the microwave oven to be connected to the same electrical supply. A single plug, therefore, may serve to connect both appliances and the current required for each appliance may be supplied by the same supply cord and circuit. In exemplary embodiments power may be supplied by the 110V AC current outlet.

To make this combination attractive for use in dorm rooms, hotel rooms, recreational vehicles, tractor trailer cabs, and other similar locations, it may be necessary to assure that the peak current draws of both appliances are not demanded from the supply at the same time. Many household circuits are protected from overload conditions by an automatic circuit breaker that is activated when current in the circuit exceeds the breaker rating. This is 15 amps in many circuits.

The duty cycle of an exemplary refrigerator used in these combined systems includes a current spike that occurs during the first few seconds of operation. This is the start up current for the refrigerator compressor. The current draw is considerably reduced as the compressor attains its full operational speed. In typical refrigerator appliances the peak current may be in the range of 7 to 9 amps, while the steady state current may level off at 1.4 amps or less. A microwave oven demands a relatively steady 8 to 13 amps of cooking power during operation of the cooking element. It is apparent that an overload condition may occur when both appliances are placed in operation absent suitable control circuitry.

In an exemplary embodiment, a combination microwave and refrigerator system is constructed having a single electrical plug input supply. The electrical supply in the exemplary embodiment is directly connected to the microwave oven. The microwave oven is adapted to provide power to the refrigerator through a power supply outlet, and to auxiliary receptacles adapted for connection to devices that operate at a low power operation draw. The microwave oven includes circuitry including a processor based controller adapted to monitor operation of the refrigerator compressor and control the power to the microwave magnetron cooking element and other components. The current draws on the low power receptacles are separately monitored for control by the microwave controller. The microwave controller is adapted to balance the duty cycles of the connected appliances in operative connection therewith to avoid overload conditions. A control logic flow is implemented internally within the circuitry of the microwave controller. A receptacle or other power connecting power supply outlet for the refrigerator and the low power auxiliary receptacle may be implemented as part of the microwave control panel on the microwave oven.

In one embodiment, the auxiliary outlets are constructed to provide low power for the purpose of recharging batteries included in cellular mobile phones, personal media devices and digital cameras, in addition to operating lap top computers and other similar low power devices. The current to the auxiliary outlets is sensed by suitable circuitry in operative connection with the microwave controller.

In another embodiment, the power to the auxiliary outlets is disabled through operation of the microwave controller when the microwave magnetron is energized or whenever the current to the auxiliary outlets exceeds a preset value.

In one embodiment, a programmed control model for control logic flow is established and executed by the microwave controller. The model is dependent on the state of operation of the microwave cooking element or elements which are referred to herein as a magnetron. As part of the exemplary control model, the power draw of the compressor is monitored to sense operation of the compressor to compress refrigerant to provide cooling. When cooking power is demanded by the microwave the compressor is disabled by having electrical power thereto withdrawn by the control circuit for a preset minimum period. When power demand to the magnetron ceases, refrigerator compressor power is restored provided that the preset minimum period has expired.

In another exemplary embodiment of the control model, sensing circuits are operative to monitor current draw on the auxiliary outlets. The control model is adapted to cause the controller to disable the power to the auxiliary receptacles, if the microwave magnetron is in operation. In addition the auxiliary receptacles are disabled if a predetermined maximum current draw is sensed. Another control model is based

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on operation of the refrigerator and operates to disable the auxiliary receptacles when the compressor is in the start up mode. Of course these approaches are exemplary and in other embodiments, other approaches may be used. Further while in the exemplary embodiment the controller is integrated with the microwave oven, in other embodiments the controller may be integrated with the refrigerator or other device, or may be configured as a separate component.

In one aspect of an exemplary embodiment, a non-transitory processor readable medium having processor executable program instructions embodied therein for operating at least one processor of a control circuit to control a system of multiple linked appliances having a microwave oven, a refrigerator, and an auxiliary power supply outlet is provided. The processor executable program code causes the control circuit to disable the refrigerator and the auxiliary power supply outlet, when the microwave demands high power such as magnetron cooking power, and enable the auxiliary power supply outlet when the microwave is not drawing cooking power.

One exemplary embodiment of a multi-appliance interconnected system 1 is illustrated in FIG. 1. This embodiment consists of two appliances, a refrigerator 3 and a microwave oven 2. Refrigerator 3 is electrically connected to microwave oven 2 by power cord 7 to refrigerator receptacle 15, shown at the rear of the microwave 2 in FIG. 2. Refrigerator 3 is generally subject to control by the microwave micro-processor controller which is alternatively referred to herein as power control circuit 4 of the microwave oven 2. The power control circuit may be operative to cause electrical power to be selectively delivered to and/or withheld from the microwave magnetron and the refrigerator compressor. A single cord 8 provides input electrical power to the system 1 from receptacle 5 through microwave 2. In the case where stand alone appliances are used, as shown in FIGS. 1 and 2, microwave oven 2 is connected directly to power source 5. The refrigerator 3, as the heaviest component, is used as the base with the microwave oven 2 stacked on top. In the selection of the refrigerator 3, it would be advantageous in some embodiments for the height of the refrigerator to be no more than 48 inches above the floor. This provides a more ergonomic operation of the microwave oven 2 for the user. In addition, in the stacked position of the appliances in an exemplary embodiment, the doors 9 and 10 of the microwave 2 and refrigerator 3, respectively, are arranged in a common plane.

At least one power control circuit 4 serves as a controller for the operation of the microwave oven 2 and is also adapted to control the other components of system 1, as shown in FIG. 3. Power is distributed throughout the system 1 under control of microwave controller 4 and digitally operated switches such as relays 19 and 20 represented in FIG. 3. It should be understood that in some embodiments the relays may control power delivery via mechanical contacts while in other embodiments, solid state relays may be used. Power is distributed to each of the appliances 2 and 3, and to auxiliary low power receptacles 11 and 12. In use lamps 13 and 14 in the form of LEDs or the like may be positioned adjacent to the auxiliary receptacles to indicate power being available from the adjacent receptacle or power to the receptacle being disabled. The low power auxiliary receptacles 11 and 12 are provided to permit convenient access for plugging in a low power device, for example, devices including rechargeable batteries, such as cellular phones, PDAs, or other electronic devices that do not demand high power. As shown in the graph of FIG. 8, there

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are instances during which, if more than one of the appliances is in use, the cumulative current would cause an overload condition.

An exemplary control panel 22 of microwave oven 2 may be adapted to provide a display of the particular status of the controlling relays. For example, LEDs 13 and 14 may indicate that power to the outlets 11 and 12 are disabled or available. In one embodiment the lamps will light when power is available at the outlet and flash when disabled. In another embodiment the lamps will light when power is not available at the outlet and not activate when power is available at the outlet as a means to reduce the standby power draw. A button operated touch panel is used in the exemplary embodiment to provide manual control.

As shown in FIG. 4, in order to control the power to the microwave 2, refrigerator 3 and receptacles 11 and 12, sensing circuits, may be coupled to the control circuit to monitor current draw by the appliance components and the auxiliary receptacles. A relay 20 is connected in the power line to the refrigerator and may be actuated by signals from controller 4. In particular, according to an exemplary embodiment, sensing circuits 16, as shown in FIG. 4, have sensors 17 and 18 coupled to the power line of the auxiliary outlets 11 and 12 to monitor the current being drawn by a connected device. Sensors 17 and 18 may include current sensing transformers of the type available from Triad Magnetics of Corona, Calif. The signals generated by sensors 17 and 18 may be used to activate switches or other control components, such as relays 19. Relays 19 may be actuated by control circuit 4 to enable and disable the delivery of power to the low power auxiliary outlets 11 and 12 in response to signals from sensors 17 and 18. A maximum current may be set through the program logic associated with the at least one power control circuit 4 to prevent overload of the outlets 11 and 12. In one embodiment of the system, the maximum current limit is set at 2 amps, and the control circuitry is operated to cease power delivery in situations where the power draw exceeds this amount. Of course this approach is exemplary.

In another embodiment, a clock function 21 included in the at least one control circuit 4 is used to provide timed delays during which, for example, refrigerator 3 would be prevented from undesirably rapid on/off cycles. When the compressor of the refrigerator 3 is disabled during microwave cooking operation, a time delay of 3 minutes is provided during which the compressor of the refrigerator 3 will remain disabled, even if microwave use is only for a short period. Control circuit 4 may be programmed to manage the power delivery to the components of the system to avoid overload conditions, while minimizing disruptions in the use of an individual appliance. A model of operative events and related control operations may be designed into the program instructions executed by at least one control circuit 4 to provide a control methodology as illustrated in FIGS. 5-7.

In one embodiment, as illustrated in the block diagram of FIG. 3, at least one control circuit 4, constructed as part of the controller for microwave 2, is adapted to receive and process the sensor signals and identify particular events in the system 1 related to a particular appliance or combination of appliance conditions. Circuit 4 controls the power to microwave 2 and refrigerator 3 and also low power receptacles 11 and 12 to avoid overload conditions. The circuit 4 is operative to execute the control methods illustrated and described below. In one exemplary embodiment, the circuit 4 is operative to control operations of microwave oven 2 and is adapted to execute the program instructions described

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below. The control circuit is coupled directly to refrigerator outlet 15 and low power outlets 11 and 12.

In one exemplary embodiment, shown in FIG. 1, the outlets 11, and 12, are included as part of the front control panel of microwave oven 2. In FIG. 2, in another embodiment, the auxiliary receptacles 11 and 12 and refrigerator receptacle 15 are accessible at the rear of the microwave oven 2. In these alternative embodiments, the microwave oven 2 is connected by supply cord 8 directly to power supply receptacle 5. Refrigerator 3 is connected by power cord 7 to receptacle 15 on microwave oven 2 as shown in FIG. 2.

In one exemplary embodiment, control models for program logic flows are established as shown in FIGS. 5-7 for execution by the at least one control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware associated with the circuit 4. The models shown are, in the first instance, dependent on the state of operation of microwave oven 2. The current demands of the microwave 2 when drawing cooking power are generally the most significant contribution to overload, as shown in FIG. 8. To avoid overload conditions, power to the low power receptacles 11 and 12 and refrigerator receptacle 15 is disabled during microwave magnetron operation. If the refrigerator 3 compressor is drawing power when the microwave 2 is turned on to commence cooking, the power to the refrigerator compressor is turned off and clock function 21 is used to determine a predetermined period during which the compressor of refrigerator 3 cannot be restarted. A time delay, for example, of 3 minutes, may be set through programming of the control circuit and when this delay period is expired, receptacle 15 may again be enabled, providing the control circuit determines in accordance with its programming and sensed parameters that microwave cooking operation has ceased. This prevents a too rapid restart of the compressor that may otherwise result in damage.

In some exemplary arrangements, the control circuitry of the power controller may operate responsive to sensing the power draw of the refrigerator and the cooking element of the microwave oven so as to detect the power draw reaching a threshold which should not be exceeded to prevent an overload condition. In other exemplary arrangements, the control circuitry may operate to detect inputs that may be provided by input devices and which are operative to cause power drawing devices such as the magnetron of the microwave oven or the compressor of the refrigerator to operate. In such arrangements, the control circuitry may operate to detect the signal from a thermostat within the refrigerator which indicates that the thermostat is signaling that the refrigerant compressor should operate to cause the temperature to be lowered within the cooling area of the refrigerator. In such arrangements, the control circuitry may operate to detect the signal from the thermostat and prevent the delivery of power to the compressor in situations where the cooking element of the microwave oven is operating. In such embodiments the control circuitry may delay the supply of power to the compressor until the cooking element of the microwave oven has ceased operation. Likewise an exemplary embodiment of the control circuitry may be operative to detect inputs to the control panel of the microwave which are provided by a user to commence microwave operation. In response to the detection of such inputs, the exemplary control circuitry may be operative to first cause a determination to be made as to whether the refrigerator is drawing the level of power that indicates that the compressor thereof

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is operating. In response to a determination that the refrigerator is drawing a level of power that is incompatible with operation of the microwave cooking element, the exemplary control circuitry may be operative to cause power to the refrigerator compressor to be withdrawn. Thereafter the control circuitry may be operative to cause power to be supplied to the cooking element of the microwave. Further in exemplary embodiments, the control circuitry may also monitor the power draw of auxiliary outlets or other power delivery points to assure that the level of draw that is currently occurring will not be an impediment to an operation that is being requested by an input device of the apparatus before the apparatus begins to operate in a manner that will cause increased power draw. Thus the exemplary apparatus enables the preventative action of discontinuing operation of a power drawing component before instituting operation of another component that draws a high level of power. Of course it should be understood that this approach is exemplary and in other embodiments, other approaches may be used.

In the embodiment shown in FIG. 5, if low power is demanded at receptacle 11 or 12 and microwave oven 2 is not in use for cooking, power is supplied to the low power receptacles, provided further, that the current demand at an individual outlet does not exceed a preset limit, for example, 2 amps. Since the auxiliary outlets may be enabled during refrigerator compressor operation, there may be an overload generated at peak compressor operation. In one embodiment the control circuitry acts to disable the auxiliary outlets during compressor startup to prevent accidental overload of the system. Therefore as illustrated in the logic flow diagram of FIG. 5, control circuitry may be adapted to check the operational status of the refrigerator, as well as the microwave oven, prior to enabling the auxiliary outlets.

FIGS. 9-11 illustrate another embodiment. In this embodiment the sensing components 117 and 118 are configured to reduce the risk of overload by the combined demands of the auxiliary outlets 111 and 112 and the refrigerator outlet 115. In the exemplary configuration as shown in FIG. 10, current sensor 117 is configured to monitor the current draw through the refrigerator outlet 115 and the circuitry is operative to limit the refrigerator current draw at the outlet 115 so that it does not exceed 10 amps. Current sensor 118 is connected to monitor the combined current in the auxiliary outlets 111 and 112. Current sensor 118 and the circuitry is to limit the combined auxiliary outlet current draw to 4 amps. In this manner the risk of overload is minimized. As represented in the block diagram of FIG. 9, the microwave 102 has at least one control circuit comprising controller 104 that is operatively connected to power supply 105. Clock function 121 which is shown schematically separately but may be part of the controller provides a timing device to determine a restart delay for power to refrigerator 103. Sensing circuit/sensor 117 is to monitor the current demanded by refrigerator 103 and sensing circuit/sensor 118 is connected to low power receptacles 111 and 112 is operative to monitor the combined current in receptacle 111 and 112. In the exemplary embodiment the control circuitry is shown as operative to control the availability of electrical power to some devices as a whole. For example, if the control circuitry operates to cause power not to be available to the refrigerator, all components of the refrigerator, such as the internal lights, air circulation fan, etc., are not supplied with electrical power, in addition to the compressor, which is the component which is most likely to draw power at a level which may be excessive. However in other embodiments, the control circuitry may be configured to deliver and withhold power

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selectively to individual refrigerator components or groups of such components. Thus in such embodiments the power control circuitry may be operative to withdraw power to the high power draw components (s) such as the compressor, while still making power available to other low power draw components such as the internal fan and/or lights.

Likewise in exemplary embodiments, the power control circuitry is operative to selectively allow power to be available or withdrawn from components of the microwave. For example, exemplary embodiments control the availability of power to selected components of the microwave such as the magnetron and the auxiliary outlets. The power control circuitry of exemplary arrangements may operate to maintain electrical operation of certain components, even though electrical power to other components is not available. For example, an exemplary controller may operate to maintain power to the clock display output on the control panel at all times. Further some exemplary arrangements may assure that power is maintained to control circuitry with programmed settings so that programmed data is not lost. This may include for example programmed data concerning a future time to turn on the cooking function, the power level and/or how long to cook. This way if the memory of the microwave has been programmed to begin to cook a food item placed inside the microwave oven at a future time so it is cooked by the time a person returns (for example) the programmed instructions to carry out those instructions will not be lost. Alternatively, configuration data that enables the microwave oven controller to communicate in a wireless network or with other devices will be preserved even though the control circuitry operates to cause electrical power not to be available to certain components. Of course these are merely examples.

It should be understood that for purposes hereof when it is stated that power is withdrawn or not made available to a microwave, refrigerator or other assembly of components, the terminology refers to not making such power available to the entire assembly or to only certain selected components that draw high power such as the refrigerant compressor or magnetron. Likewise herein references to the microwave or the refrigerator operating or running refers to operation of the respective high power draw components such as the magnetron or the compressor, for example.

In the exemplary embodiment, as shown in FIG. 11, a control panel 122 is arranged with a keypad 123 for manual control and a display 124. Auxiliary outlet 111 is shown as accessible from the front and is associated with a status LED indicator and reset button 113 that may be caused to be operative during use and switch to a flashing mode when the microwave is drawing cooking power. Refrigerator outlet 115 is also accessible on the front panel and is associated with an LED indicator and reset button 114. Similarly LED indicator 114 is controlled to be on by being illuminated during use of the refrigerator and to switch to a flashing mode when the microwave is drawing cooking power. In another exemplary embodiment, the status LED indicator and reset button 113 may be caused to be off during use and switched on or to a flashing mode when the microwave magnetron is drawing cooking power. Similarly, in this embodiment, the LED indicator 114 is controlled to be off during operation of the refrigerator compressor and switched on or to a flashing mode when the microwave radiation cooking element is operating.

A further embodiment of the logic flow operational model is shown in FIG. 6. In this model, the refrigerator compressor draws or demands power. This may be triggered by a temperature rise of the refrigerator interior area within the

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housing of the refrigerator and involve start up of the refrigerator compressor with an associated peak power demand. If the microwave cooking element is sensed by the control circuitry as currently drawing cooking power, the programming of the control circuitry causes power not to be available the refrigerator so that operation of the refrigerator compressor will be delayed. If the microwave cooking element was on and subsequently cycled off, the clock function 21 must be checked by the controller to determine if power availability to the refrigerator to restart can occur. Under some circumstances, it may be necessary to give the refrigerator compressor priority to prevent an undesirable rise in temperature. In the latter instance, the control circuit can be coupled to the refrigerator temperature sensor to execute a programmed sequence during which the microwave cooking element will be disabled by not having power supplied thereto to allow the refrigerator to operate long enough to return to proper operating temperatures.

In the embodiment of FIG. 7, the exemplary control circuitry operates to give priority to the power demands of the microwave oven, as indicated above. Use of the receptacles 11, 12, and 15 are, therefore, caused to be disabled during microwave cooking operation. The operational models which carry out the logic represented in FIGS. 5-7, may be established by logic flows implemented by instructions that are programmed or imbedded in the control circuitry of controller 4.

In this manner a system of linked appliances, including a microwave oven, refrigerator, and at least one low power draw device or appliance may all be connected through a common supply cord to a receptacle providing house current or other electrical power level without the risk of inconvenient interruptions or damage during use caused by overloads.

It is also advantageous to provide such a combination microwave/refrigerator system that also provides auxiliary outlets for low power applications, such as for the purpose of recharging batteries in cellular phones, operating lap top computers and other low power devices, while controlling the operation of the appliances to avoid overload conditions.

In another exemplary embodiment as illustrated in FIGS. 12 and 13, the auxiliary outlets or electrical power receptacles 211, 212 may be included as part of the front control panel 222 of the microwave oven 202 and located on the upper portion 270 of the front control panel 222. The auxiliary outlets 211, 212, front control panel 222 and microwave oven 202 are similar to auxiliary outlets 11, 12, front control panel 22, and microwave oven 2 except as discussed below. In this exemplary embodiment, the auxiliary outlets 211, 212 are positioned side by side with respect to each other with each of the auxiliary outlets 211, 212 being at the same height as the other. The auxiliary outlet 211 of FIG. 12 may be associated with a status LED indicator and reset button 213, which is located on the lower portion 272 of the front control panel and in vertical alignment with the auxiliary outlet 211. The status LED indicator and reset button 213 may be caused by the control circuitry of the controller to be on during use and switched to a flashing mode to indicate that power is not available therefrom when the microwave oven 202 is drawing cooking power. The auxiliary outlet 212 of FIG. 12 may be associated with status LED and reset button 214, which is located on the lower portion of the front control panel and in vertical alignment with the auxiliary outlet 212. The status LED indicator and reset button 214 may be caused by the controller to be on during use and switched to a flashing mode to indicate that power is not available therefrom when the

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microwave oven 202 is drawing cooking power thereto is withdrawn. In another exemplary embodiment, the status LED indicator and reset button 213 may be caused to be off during the time power is available for use and switched on or to a flashing mode when the microwave oven is running and power thereto is withdrawn. Similarly, in another embodiment, the status LED indicator and reset button 214 may be caused to be off during power availability and switched on or to a flashing mode when the microwave oven is running or the refrigerator is running and the controller causes power not to be available. Other elements and operational features may be similar in structure and function as that of the embodiments shown in FIGS. 1-11. Thus, the same reference numbers will be used in this exemplary embodiment to indicate elements that are similar in the embodiments shown in FIGS. 1-11.

Smart technology may be integrated in some of the exemplary embodiments. For example, a user may be able to monitor and/or control the refrigerator 3 such as by turning it on and off remotely by a remote device 217. The remote device 217 may include a hand held device such as a cellular phone. The cell phone may also be a smart phone. In some exemplary embodiments, the refrigerator, the microwave and/or the controller may include circuitry suitable for communication in a wireless network. Such a wireless network may be established in the facility, residence, office or other location where the combined refrigerator and microwave appliance is operated. Such devices may include circuitry that enables transmission of wireless signals to and from such components. Such communications may include communications of operational properties such as operating status, temperature, programmed values or other information that is pertinent to the operational condition of the particular device. In further exemplary arrangements, circuitry may be operative to enable received wireless messages to modify the operational condition and/or the programming of the particular device.

For example in some exemplary arrangements, the user may be able to communicate from a wireless phone via cellular or WiFi connection to determine that the refrigerator is operating, the temperature therein, the operational status of the compressor or other items. Alternatively and/or in addition, the user may be able to remotely control components of the refrigerator. These may include, for example, the ability to remotely turn on the internal light within the refrigerator and to view the food items currently housed within the refrigerator via one or more electronic cameras positioned therein. This may enable a user, for example, to determine that they need to purchase additional groceries or other items for purposes of an upcoming meal or other activities. Alternatively and/or in addition, in some exemplary embodiments, instructions may be utilized to change the temperature within the refrigerator. This may be done, for example, to chill certain grocery items that may need to be cooled or frozen for certain purposes. Of course these approaches are exemplary.

Likewise the microwave may include interface circuitry which enables the remote monitoring of the condition of the microwave components via a remote wireless device. This may include, for example, determining the periods of past operation and current status of the microwave such as whether it is currently being used to cook items. Alternatively and/or in addition, the remote monitoring capabilities may include determining the programmed status of the controller of the microwave such as the controller being programmed to cook an item housed in the microwave at a set future time or for a particular duration at a particular

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power level. Alternatively and/or in addition, the remote operational capabilities associated with the microwave circuitry may include the ability to turn on an internal light within the cooking chamber of the microwave and to view via a camera whether an item is contained therein. Further such remote capabilities may also include the ability to remotely change the program parameters so as to initiate cooking at a different time or at a different power level. Likewise exemplary arrangements may include having the wireless interface in operative with the power control circuit to provide the ability to monitor the current status of power draw on auxiliary outlets, the occurrence of alarm conditions, or the current status of other connected devices. It should be understood that such capabilities may be implemented in the controller circuitry or in separate circuitry of the microwave and/or the refrigerator. Further the exemplary arrangements may utilize communications interface capabilities included in circuitry of the controller to facilitate monitoring and operational control of the appliance. Of course these capabilities are exemplary and in other embodiments, other approaches may be used.

In an exemplary embodiment a charging pad 219 (FIG. 14) may be provided on the microwave oven 2 or other suitable location to receive a smart phone or other chargeable device for purposes of charging the device. For example, a wireless charging pad 219 may be positioned on top 225 of the microwave oven 2 for recharging the smart phone or other device. The charging pad 219 may be built into the top 225 of the microwave oven 2 or may be a separate component that is mounted to the top 225 of the microwave oven 2 or other location. The exemplary charging pad 219 includes an inductive charging pad and includes a recessed area 220 for receiving an item to be charged such as the smart phone. The control circuitry may include or be in operative connection with a wireless interface 221 configured for communicating with the remote control device 217 for controlling the microwave or refrigerator and work in conjunction with the control circuitry to perform functions such as removing the supply of electrical power to the microwave oven 2 and/or refrigerator 3. In an exemplary arrangement, USB ports 223, 224 may be provided in the area of the charging pad 219. Alternatively, or in addition, power outlets may be provided in proximity to the charging pad 219. Alternatively, the charging pad 219 may be provided on the front, side, rear or bottom of the microwave oven 2, or at another suitable location in connection with the combined appliance structure.

The exemplary charging pad 219 may utilize inductive or wireless charging, which uses an electromagnetic field to transfer energy between the charging pad 219 and the device being charged. In general, the charging pad 219 may include a primary inductive coil 402 (FIG. 28) in connection with circuitry that is operative to create an alternating electromagnetic field that is received by a secondary inductive coil 404 (FIG. 28) connected to the circuitry of the device being charged such as device 217. Power from the electromagnetic field is converted back into electric current to charge a battery 406 (FIG. 28) in the device. FIG. 28 shows an exemplary arrangement in which the charging pad 219 utilizes inductive charging to charge the device 217. In this arrangement, the charging pad 219 includes an inductive charging station 408 and the primary inductive coil 402. The power source 5 provides electrical power to the inductive charging station 408 and the other components of the charging pad 219.

The inductive charging station 408 is provided for inductively charging the device 217 and may be built into or

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otherwise attached to the charging pad 219. The inductive charging station 408 may include the primary inductive coil 402 that is connected to the power source 5 for the microwave oven 2. The recessed area 220 may define a cover of the charging pad 219 that covers the primary inductive coil 402 and provide a surface on which the remote device 217 may be placed for charging. The inductive charging station 408 may also include one or more capacitors coupled in series and/or parallel with the primary inductive coil 402 to form an LC circuit. The inductance value of the primary inductive coil 402 and the capacitance value of the capacitor or capacitors may be selected to achieve a desired resonant frequency which corresponds to a frequency of a coil and circuitry in the device being charged, but it should be noted that this exemplary arrangement is not limited to any particular inductance and/or capacitance values and/or any particular power source ratings.

The device 217 or other device to be charged may include the battery 406 that provides electrical power to the components and circuitry of the device. The battery 406 may comprise a rechargeable battery or batteries including lead acid, nickel cadmium (NiCad), nickel metal hydride (NiMH), lithium ion (Li-ion) or lithium ion polymer (Li-ion polymer) batteries. The device may include any number of batteries, the size and rating of which may vary. The battery 406 may also comprise power conduits, connectors, receptacles, battery connectors, or power cables coupled with batteries.

The device 217 or other device to be charged may include an inductive charger 410 for charging the battery 406 when the device 217 is placed on or in the vicinity of the inductive charging station 408 of the charging pad 219. The inductive charger 410 may be built into or otherwise attached to the device to be charged. As schematically represented in FIG. 28, the inductive charger 410 may include the secondary inductive coil 404 and a charging circuit 412 that is connected to the battery 406. The inductance value of the secondary inductive coil 404 may be selected to correspond or complement the inductance value of the primary inductive coil 402, but it should be noted that in exemplary arrangements the secondary inductive coil is not limited to any particular inductance value. Likewise, the power rating of the charging circuit 412 may be selected to match or complement the rating of the battery 406. The two inductive coils 402, 404 in proximity combine to operate in a manner similar to the principles employed in an electrical transformer. Further in some embodiments greater distances between primary and secondary inductive coils and/or more effective charging can be achieved when the inductive charging system uses resonant inductive coupling. Of course the described approaches are exemplary and in other embodiments other approaches may be used. In some exemplary embodiments the charging pad may be in operative connection with the control circuitry that controls power availability to components of the device. For example, the control circuitry may operate in accordance with its programmed instructions to cause power to not be available to the charging pad when the microwave draws cooking power.

Alternatively or in addition the control circuitry may be operative to cause power not to be available to the charging pad responsive to power draw by the refrigerator compressor, the auxiliary outlets or other items, and/or cumulative power draw of multiple items.

As seen in FIGS. 16, 18, and 20, a safety sensor which is alternatively referred to herein as a safety circuit 226 such as a smoke or gas sensor may be provided in connection with the microwave oven 2. The smoke sensor 226 operates in

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connection with exemplary control circuitry to turn off the microwave oven upon sensing smoke or polluted air indicative of a potentially dangerous condition such as excessive smoke generated from overcooked food. The exemplary safety sensor 226 may be powered on or otherwise operational when the microwave oven is in operation. The sensor circuitry may operate responsive to processor executable instructions to determine the optimal activation point. The exemplary smoke sensor may be battery-powered or powered by the house current that powers the combined appliance with an optional battery backup when the power from the house current is out. The smoke sensor may include an ionization smoke sensor that uses a radioisotope, typically Americium-241, to ionize air. The ionization smoke sensor circuitry operates to turn off power to the magnetron cooking element of the microwave oven upon sensing a difference due to smoke indicative of a potentially dangerous condition. The smoke sensor alternatively may include a radiation type smoke detector that may contain a source emitter of infrared, visible, or ultraviolet light (typically an incandescent light bulb or light-emitting diode), a lens, and a photoelectric or other type of radiation sensing receiver (typically a photodiode) and suitable control circuitry.

An exemplary sensor 226 may include an alcohol sensor that is coupled with a thermistor 228. An exemplary alcohol sensor 226 may operate in a set temperature range, such as from 32 to 104 degrees Fahrenheit. When a set level of heating is sensed by the thermistor 228, the thermistor 228 through suitable control circuitry causes the alcohol sensor 226 to turn on and become operational and check for properties of the gas within the interior area of the microwave.

If the exemplary alcohol sensor 226 is operational due to the sensing of the set level of heating and senses polluted air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor to the controller 104. Upon receiving the shutdown signal, the controller 104 determines that the radiation cooking emitting element of the microwave oven 2 should be shut down and causes the magnetron of the microwave to shut down through the withdrawal of electrical power. If (after the alcohol sensor is caused to be turned on by the thermistor) the alcohol sensor 226 senses air that is not indicative of a dangerous condition such as the air produced by normal cooking of food in the microwave oven 2, the alcohol sensor circuitry will not send a shutdown signal to the controller 104 and the controller allows the microwave cooking activity to continue.

Alternatively or in addition, a fault indicator 230 may be coupled to the control circuitry of the controller 104 or other circuitry to indicate that there is a dangerous condition upon detection by the alcohol sensor 226. For example, the fault indicator 230 may be a buzzer that is activated in response to the alcohol sensor 226 sensing polluted air indicative of a dangerous condition. In another example, fault indicator 230 may include the display 124 displaying a fault message such as "E-1" in response to the alcohol sensor 226 detecting polluted air indicative of a dangerous condition. Alternatively the fault indicator may output one or more signals, such as wireless alarm signals that can be detected by a receiver of an alarm system or through a remote device such as a smart phone.

An exemplary embodiment may include a combination of fault indicators. For example, upon the alcohol sensor 226 sensing air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor 226 to the controller 104. Upon receiving the shutdown signal, the controller 104 determines that the microwave oven 2 should

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be shut down and causes the radiation emitting cooking element of microwave oven 2 to be shut down. In addition in an exemplary embodiment, a buzzer is activated and the display 124 displays a fault message such as "E-1" in response to the alcohol sensor 226 sensing polluted air indicative of a dangerous condition.

The alcohol sensor 226 may be reset automatically responsive to the alcohol sensor 226 no longer detecting gas indicative of the dangerous condition. Alternatively or in addition, the alcohol sensor 226 may be reset upon sensing by a suitable switch, opening of the microwave door 9 of the microwave oven 2. The display may display a "bar" or other suitable icon to indicate that the alcohol sensor 226 is turned on. Other types of suitable safety sensors may also be used instead of the alcohol sensor to detect a dangerous condition within the cooking area of the microwave.

In addition to one or more sensors which detect the gases generated from cooked food, the sensor 226 may include a temperature sensing capability such as, for example, using the thermistor 228 and related elements mentioned above.

Referring to FIG. 24, in another exemplary embodiment, the safety sensor which is alternatively referred to as a safety circuit may comprise an infrared sensor 326. The infrared sensor 326 may include two oppositely positioned infra-red disposed infrared sensor elements in the form of a sensor emitter 328 and sensor receiver 330 (schematically shown in FIG. 24) provided on the microwave oven and located in the microwave's cavity 332. The exemplary infrared sensor 326 operates as follows. The sensor emitter 328 emits radiation and the sensor receiver 330 senses sensor radiation from the sensor emitter 328 while the microwave element operates during a cooking session. When smoke that is indicative of a dangerous condition passes in between the infrared sensor elements 328, 330, a determination is made by the safety circuit that a transmission amount of sensor radiation from the sensor emitter reaching the sensor receiver has fallen by at least a programmed threshold amount during the cooking session, due to smoke in the cooking interior area. Responsive to the determination, the cooking element of the microwave oven is caused by the safety circuit to be no longer supplied with electrical power. The exemplary safety circuit may use the smoke point of oil or similar food products as the basis for its threshold amount, so that normal smoke emitted during the cooking or heating of food or beverages will not cause the infrared sensor 326 to deactivate cooking operation. The exemplary infrared sensor 326 would not require interaction from the microwave user. The exemplary safety sensor may be operative to cause an initial transmissivity level of sensor radiation that reaches the sensor receiver from the sensor emitter early in the cooking session to be stored in a data store or other memory associated with the safety circuit. The determination of a level of smoke corresponding to a dangerous condition is made in this embodiment responsive to circuitry operating in accordance with programmed instructions to detect that the transmission amount of sensor radiation reaching the sensor receiver has dropped by the threshold amount from the initial transmissivity level during the cooking session.

Referring to FIG. 25, in another exemplary embodiment, the safety sensor or safety circuit may comprise a light sensor 334, which detects the increase smoke density within the microwave's cooking area which is alternatively referred to as a cavity. The light sensor 334 may also include a sensor emitter and sensor receiver. The light sensor 334 may be provided in the microwave cavity 332 and may operate as follows. At the beginning of a cooking cycle, the light generated travels through the clean air to the light sensor

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334. As smoke increases in density, the amount of light that reaches the sensor receiver is reduced. The circuitry of light sensor 334 includes a programmed trip point or threshold that corresponds to the reduced amount of light sensed caused by the amount of smoke, that is indicative of a dangerous condition. When the trip point is reached, the safety circuit causes the electrical power to the radiation emitting cooking element to be withdrawn. A circuit determination would be made based on the amount of smoke that corresponds to the trip point and its corresponding light sensor reading.

Referring to FIG. 26, in another exemplary embodiment, the safety sensor may include an optical motion sensor 336. The optical motion sensor 336 may also include a sensor emitter and sensor receiver. The optical motion sensor 336 may be positioned in the microwave cavity 332 adjacent air exhaust vents 338, 340 of the microwave, which comprises an air passage that connects an area where food is cooked in the microwave oven to the air outside the housing of the microwave oven. The optical motion sensor 336 detects motion which is sensed due to the presence of smoke blown by an exhaust fan 342 of the microwave oven 2 through the air passage. The exhaust fan 342 is operative to cause air to move in the air passage connected to the microwave cavity. In an exemplary arrangement, the sensor emitter and sensor receiver are positioned to be operative to sense the transmission of radiation between the emitter and the receiver in the air passage. The optical motion sensor 336 has a trip point or threshold that corresponds to the presence of smoke of a predetermined density that corresponds to a reduced level of transmission that is indicative of a dangerous condition. When the trip point is reached, the optical motion sensor causes the cooking element of the microwave oven to be turned off. It should be noted that the exemplary optical motion sensor is not be positioned within the microwave cavity and directed toward a turntable therein, since the turntable itself may result in false alarms in some configurations. Of course it should be understood that other types of smoke sensors may be positioned in air passages in other alternative embodiments.

Alternative embodiments may include other types of smoke sensors. For example, some embodiments may include sensors that are operative to detect smoke by determining the level of volatile organic compounds (VOCs) in the air in the microwave oven cooking area. In some exemplary embodiments such VOC sensors may be positioned to sense air in at least a portion of the microwave cooking area. In some cases such VOC sensors may be positioned in an air passage that extends between the microwave cooking area and the air in the atmosphere outside the microwave. Such an arrangement may have an advantage in that positioning the sensor in the air passage may minimize the amount of cooking splatter and other contamination from the food cooked in the microwave oven that reaches the sensor.

Some exemplary arrangements may include a VOC sensor that comprises a tin dioxide semiconductor gas sensor. In some arrangements the semiconductor is formed on an alumina substrate with a thick film heater of ruthenium oxide on the reverse side. Of course this configuration is exemplary and in other embodiments other arrangements and VOC sensor types may be used.

In exemplary microwave oven arrangements VOC sensors may be operated in conjunction with suitable control circuitry to detect conditions which correspond to a dangerous smoke condition. Such a dangerous smoke condition is determined responsive to the level of VOCs, such as carbon

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dioxide and/or carbon monoxide in the air in the cooking area of the microwave oven. Such compounds may generally indicate the presence of combustion which is corresponds to a potentially dangerous condition. Responsive to detecting a threshold VOC concentration in the air of the cooking area, the control circuitry in operative connection with the sensor is operative to cause power to be withdrawn from the magnetron of the microwave oven so as to prematurely end a current cooking session before the set and time thereof. In exemplary arrangements, the sensitivity of the VOC sensors is sufficient to detect a developing potentially dangerous condition and cause power to be withdrawn from the microwave cooking element before a fire or other condition causes damage to the microwave oven. This enables the sensor circuitry to reset when the dangerous smoke condition is no longer detected and enable the microwave oven to operate in a subsequent cooking session.

In some exemplary arrangements multiple sensors in operative connection with detection circuitry is utilized to determine the activation point for an alarm condition based on detection of parameters such as humidity, temperature, temperature rate of change, and gas constituents generated during cooking phases. Combinations of absolute and relative values and rates of change thereof may be detected for purposes of evaluating possible alarm conditions. Other types of sensors that may be used in exemplary embodiments include flame sensors. Flame sensors are operative, detect and provide signals indicative of the presence of a flame or fire. Upon the flame sensor detecting the presence of a flame, the flame sensor causes the controller to discontinue electrical power to the microwave oven cooking element. In some arrangements the flame sensor may take the form of an optical flame sensor. The flame sensor may be of the type that utilizes ionization current flame detection. Alternatively, the flame sensor may be of the type that utilizes thermocouple flame detection.

Alternatively or in addition, the fault indicator 230 may be coupled to the controller 104 or other circuitry to indicate that there is a dangerous condition upon detection of a potentially dangerous condition by any of the infrared sensor 326, light sensor 334, optical motion sensor 336, or flame or fire sensor in the embodiments described above. For example, the fault indicator 230 may be a buzzer that is activated in response to the safety sensor 226 sensing polluted air indicative of a dangerous condition. In another example, fault indicator 230 may include the display 124 displaying a fault message such as "E-1" in response to the safety sensor 226 detecting polluted air indicative of a dangerous condition.

Exemplary embodiments may include a combination of fault indicators. For example, upon the trip point or threshold value being reached by any of the detection circuitry of the infrared sensor 326, light sensor 334, or optical motion sensor 336, a shutdown signal is outputted by the sensor 226 to the controller circuitry 104. Upon receiving the shutdown signal, the controller 104 determines that the microwave oven 2 should be shut down and causes electricity to be withdrawn from the cooking element. In addition, a buzzer is activated and the display 124 displays a fault message such as "E-1" in response to the sensor 226 sensing polluted air indicative of a dangerous condition. In other exemplary embodiments, the controller or other circuitry may be operative to output signals that can be communicated to a remote location, indicative of an alarm condition that is detected through one or more detection circuits of the microwave oven or other connected devices. This may include, for example, the circuitry dispatching messages to a remote

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device such as a smart phone of a user. The messages caused to be dispatched responsive to operation of the control circuitry may be indicative of an alarm condition that can be output on the display of the user's device to advise that a potentially dangerous condition exists. Alternatively and/or in addition, the control circuitry may be operative to communicate messages to a central controller or alarm panel located in the facility or institution in which the microwave is operated. For example the circuitry may be operative to provide wireless communication to an alarm panel or central monitoring station which receives the information that there is a potentially dangerous condition at the microwave device located in a particular location, dormitory room or other identified area of the building or facility. In still other exemplary arrangements, messages corresponding to alarm conditions that are cause to be sent by the control circuitry of exemplary arrangements may be dispatched to devices or alarm monitoring stations of a security force for an oversight authority within the area in which the microwave is operated. Of course it should be understood that these approaches are exemplary and in other embodiments, other approaches may be used.

The exemplary detection circuitry of the smoke sensor, infrared sensor 326, light sensor 334, or optical motion sensor 336, may be reset automatically upon the sensor not detecting gas or other conditions that are no longer indicative of the dangerous condition. Alternatively or in addition, the sensor may be reset upon circuitry sensing opening of the microwave door 9 of the microwave oven 2. The display may display a "bar" or other suitable icon to indicate that the sensor is turned on. Other types of suitable safety sensors and circuitry may also be used to detect dangerous conditions. Further in other exemplary embodiments, other circuitry may be in operative connection with the combined appliance or separate components so as to address dangerous conditions. Such items may include, for example, a suitable fire extinguishing system that may be automatically triggered in response to detecting conditions corresponding to fire or smoke within the cooking chamber of the microwave oven. For example in some exemplary arrangements, a compressed supply of carbon dioxide may be included with or be positioned adjacent to the combined appliance. A suitable gas conduit and control valve may be positioned to deliver the carbon dioxide into the cooking chamber of the microwave oven responsive to the detection of flame, excessive temperature or smoke within the microwave cooking chamber. Suitable circuitry in operative connection with the controller or circuitry of the temperature, smoke or flame detection devices may operate to cause the control valve for the delivery of the carbon dioxide or other fire extinguishing material to be opened to cause the delivery thereof responsive to the detection of one or more of the alarm conditions. Further as can be appreciated, in some exemplary arrangements, the control circuitry may operate in accordance with its programmed instructions to require that the alarm condition be detected as existing for a programmed period of time before the control circuitry operates to cause the fire extinguishing material to be delivered into the cooking chamber. Further although exemplary arrangements may include carbon dioxide as the fire extinguishing material, in other embodiments other types of fire extinguishing or fire suppressing materials may be utilized. These may include, for example, chemical fire extinguishing or retarding materials in the form of powders or foams. Alternatively, and/or in addition, fire suppressing materials may include the

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delivery of nonflammable gaseous material. Of course these approaches are exemplary and in other embodiments, other approaches may be used.

As shown in FIGS. 15, 16 and 27, the exemplary front control panel 22 of the microwave oven 2 may include Universal Serial Bus (USB) ports 232, 234 for connection, communication, and power supply between the front control panel 22 and electronic devices such as a personal computer, cell phone, Smart Phone, Ipad®, or other suitable electronic device plugged into the USB ports. In one exemplary embodiment, a first USB port 232 may be provided on the upper portion 236 of the front control panel 22, and a second USB port 234 may be provided on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112 and between the reset buttons 113, 114 as seen in FIG. 15. The first USB port 232 may be operatively connected to a three ampere fuse and a linear time-variant system (LVT) of 100 mA, 120 volts, and 12 watts. The second USB port 234 may be operatively connected to a linear time-variant system (LVT) of 200 mA, 120 volts, and 24 watts. The second USB port 234 may also be reset. The current sensor 118 may be constructed to limit the second USB port and the two auxiliary outlets to 12 amps. The USB ports 232, 234 may be in operative connection with respective printed circuit boards. Alternatively, as represented in FIG. 27, instead of auxiliary outlet 111, another USB port 237 may be provided on the front panel 22 at the location of the auxiliary outlet 111. Alternatively or in addition, one or more USB ports may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively or in addition, one or more auxiliary outlets may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively, the refrigerator outlet may be provided on the top, bottom, or one of the sides of the microwave oven.

FIGS. 17 and 18 show another exemplary arrangement of a control panel and control circuitry that includes USB ports 232, 234. In this arrangement, the first and second USB ports 232, 234 are located side by side on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112. The USB ports 232, 234 are also located rightwardly (as viewed in FIG. 17) adjacent a status LED indicator and reset button 240. In this exemplary arrangement, current sensor 218 is configured to monitor the combined current in the USB ports 232, 234 and the auxiliary outlets 111 and 112. The current sensor 218 is constructed to limit the combined current in the USB ports and auxiliary outlets 111 and 112, to 12 amperes. The LED indicator and reset button 240 may be controlled to illuminate when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and flash when disabled. In another embodiment, the LED indicator and reset button 240 may be controlled to be off when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and light on illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables power delivery from the auxiliary outlets 111, 112 and the USB ports 232, 234 so that power may be again supplied from them after a power interruption due to excessive power draw, when the combined current draw falls from above to below the limit. Of course it should also be understood that in exemplary arrangements, the controller or other control circuitry that operates to avoid excessive power draw may also operate to discontinue delivery of power from the receptacles and the USB ports in circumstances where the power draw of the

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microwave cooking element and/or the refrigerator compressor requires the power delivery from the auxiliary outlets and USB ports be discontinued. In such exemplary arrangements, the control circuitry may operate to automatically resume the delivery of power to such receptacles and ports or in other embodiments, or a manual input may be required to cause the delivery of power to be reinstituted. Of course it should be understood that these approaches are exemplary and in other embodiments other approaches may be used.

FIGS. 19 and 20 show an alternative arrangement in which one USB port 234 is located above the auxiliary outlets 111, 112 and rightwardly adjacent the status LED indicator and reset button 240. In this exemplary arrangement, the current sensor 218 is configured to monitor the combined current draw from the USB port 234 and auxiliary outlets 111 and 112. The current sensor 218 is configured to limit the combined current draw from the USB port 234 and auxiliary outlets 111 and 112, to 12 amperes. Alternatively, the current sensor 218 may be configured to limit the combined current in the USB port 234 and the auxiliary outlets 111 and 112 to 13 amperes. The LED indicator and reset button 240 may be controlled to illuminate when power to the auxiliary outlets 111, 112 and the USB port 234 is available, and flash when the control circuitry causes the outlets and ports to be disabled. In another exemplary embodiment, the LED indicator and reset button 240 may be off when power to the auxiliary outlets 111, 112 and the USB port 234 is available, and illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables operation of the auxiliary outlets 111, 112 and the USB port 234 so that power may be again supplied from them after the controller discontinues the supply of power thereto when the combined current draw falls from above to below the limit. Of course as is the case with the previously described embodiment, the controller and other circuitry may be operative to also discontinue the supply of electrical power to the auxiliary receptacles and/or USB ports when power draw is required for the magnetron of the microwave or the refrigerator compressor is sensed that power delivery to other devices needs to be discontinued to limit excessive power draw. In such circumstances, the discontinuance of power to the auxiliary receptacles and USB ports may be automatically reinstated responsive to operation of the controller. Alternatively, in other arrangements, manual inputs may be required from a user to reinstitute the electrical delivery therefrom. Further in some exemplary arrangements, the controller may be configured so as to require manual inputs to reinstate electrical delivery only under circumstances where excessive power draw above the limits from the one or more auxiliary outlets or USB ports has occurred, thus requiring a manual input to reinstitute the electrical power delivery therefrom. Of course these approaches are exemplary and in other embodiments other approaches may be used. Other elements of the embodiments of FIGS. 17-20 may be similar in structure and function as the embodiments shown in FIGS. 1-11. Thus, the same reference numbers are used in describing these exemplary embodiments to indicate elements that are similar to elements or components in the embodiments shown in FIGS. 1-11.

FIG. 21 shows the rear portion 244 of the exemplary microwave oven of the embodiments shown in FIGS. 12-20. Refrigerator outlet 15 is shown on and accessible from the rear portion 244 of the microwave oven and is associated with the LED indicator and reset button 214, which is also provided on the rear portion 244 of the microwave oven.

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FIG. 22 is a similar view as FIG. 21 except that an AC electrical cord 8 for the microwave oven is shown.

In the embodiments shown in FIGS. 12-22, control models for control logic may be established for execution of executable instructions by the controller or microprocessor which is also referred to herein as at least one control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware within the control circuit 104. The exemplary models and logic flow are; in the first instance, dependent on the state of operation of the microwave oven 2. The current demands of the microwave oven 2 are generally the most significant contribution to overload. To avoid overload conditions, in exemplary arrangements power to the low power receptacles or auxiliary outlets, refrigerator receptacle, and/or USB ports is disabled during microwave operation.

FIG. 23 shows a flow chart illustrating several control models for operational scenarios. The control circuit 104 begins by determining whether the microwave oven is turned on or operating (e.g. cooking) in step 246. When the microwave oven is turned on and operating to perform cooking, the rear refrigerator outlet 15, the two auxiliary outlets 111, 112 on the front control panel 22, and the two USB ports 232, 234 on the front control panel are all turned off or disabled, so that the total draw of current for the combination microwave and refrigerator is not over 15 amperes as indicated in step 248.

When the microwave oven is not drawing cooking power and items are plugged into the two USB ports 232, 234, two auxiliary outlets 111, 112, and rear refrigerator outlet 15, then the exemplary control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 2 amperes (approximately the average amperes when the refrigerator compressor is running) in step 250. If the refrigerator outlet 15 is drawing less than 2 amperes, then all the outlets 15, 111, 112 and USB ports 232, 234 are caused to be enabled, so that power may be supplied through them as indicated in step 252. If the refrigerator outlet 15 not drawing less than 2 amperes, the control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 254. If the refrigerator outlet 15 is drawing less than 14 amperes but not less than or greater than or equal to 2 amperes, then the auxiliary outlets 111, 112 and USB ports 232, 234 are disabled or turned off so that no power may be supplied from them as indicated in step 256. The refrigerator outlet 15 remains enabled. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 is disabled in step 258. This may be accomplished by tripping the relay 20 of the reset circuit off. In addition, the red LED light on the LED indicator and reset button 214 is turned on to identify the disabled condition of the refrigerator. Then, in step 260, the auxiliary outlets 111, 112 and USB ports 232, 234 are enabled so that power may be supplied through them.

Then, the exemplary control circuit determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 262. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 remains disabled and the red LED light on the LED indicator and reset button 214 remains turned on to identify the disabled condition of the refrigerator 3. This condition may occur, for example, if an electrical heater is plugged into what is normally used as the refrigerator electrical supply outlet 15. When the refrigerator outlet 15 draws less than 14 amperes resulting from the

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overload condition being eliminated, the refrigerator outlet 15 will be enabled by the control circuit so that power may be supplied to the refrigerator outlet 15 upon the LED indicator and reset button 214 being depressed as indicated in step 264. Depression of the LED indicator and reset button 214 in this condition will also turn off the red LED light. The process then ends. It should be noted that the at least one control circuit 104 can make the determination in steps at the same time or in a different order.

It should be understood that in exemplary embodiments, determination as to the power draw from receptacles that have been disabled, may be determined through a process of again supplying power output through the receptacle. The power draw from the receptacle is monitored continuously after the power is restored and if it is detected that the power draw exceeds a threshold or other determined amount, power is discontinued to the receptacle. In some exemplary arrangements, the power sensing circuitry may operate in conjunction with the controller to calculate the current power draw level. The control circuitry may also operate in accordance with its programming to determine that other connected devices are consuming power which may necessitate not providing power to the receptacle so as to avoid an overload condition. Alternatively or in addition, the control circuitry may be operative to monitor other conditions that may be indicative of a problem when the power is restored to a receptacle, port or other control outlet. For example, responsive to a manual input to reinstitute the supply of power thereto, the control circuitry may operate to recognize conditions that correspond to an electrical short or other malfunction which necessitates an immediate withdrawal of electrical power thereto. This may include, for example, monitoring the rate at which power is drawn and the current flow increases to detect a short or other fault condition. Numerous different types of detection circuitry and control approaches may be implemented in order to help assure that if power output has been discontinued, that excessive power draw or undesirable conditions are not a problem when power is reinstated.

Although exemplary embodiments are described herein as used in conjunction with vapor compression refrigerators, embodiments employing the principles described herein may also be used with other types of refrigerators. Such refrigerators may include refrigerators that use thermoelectric cooling, such as Peltier elements to provide cooling. Other embodiments may include absorption refrigerators to provide cooling. In such embodiments the components of the refrigerator apparatus which draw electrical power, are controlled through operation of at least one control circuit, to prevent, suspend or defer the operation thereof at times when the microwave radiation emitting cooking element of other components that draw electrical power are to be operated, so as to avoid exceeding a maximum threshold for current draw for the combined appliance that is permitted by the at least one control circuit.

It should be understood that the above description is only illustrative of the exemplary embodiments. Various alternatives and modifications can be devised by those skilled in the art without departing from the teachings of exemplary embodiments. Accordingly, the present application is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

Thus the exemplary systems, arrangements, and methods of operation that have been described herein achieve desirable capabilities, eliminate difficulties encountered in the use of prior devices and systems and attain the useful results described herein.

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In the foregoing description, certain terms have been used in describing exemplary embodiments for purposes of brevity, clarity and understanding. However, no unnecessary limitations are to be implied therefrom because such terms are used for descriptive purposes and are intended to be broadly construed. Moreover, the descriptions and illustrations herein are by way of examples and the inventive features are not limited to the particular features shown and described.

Further it should be understood that elements, features, relationships, devices and other aspects described in connection with one exemplary embodiment may be utilized in connection with other exemplary embodiments such that numerous different arrangements, functions and capabilities may be carried out. Numerous different aspects of described embodiments may be used together or in different combinations to achieve useful results.

Having described the features, discoveries and principles of the exemplary embodiments, the manner in which they are constructed and operated, and the advantages and useful results attained, the new and useful structures, devices, elements, arrangements, parts, combinations, systems, equipment, operations, methods, processes and relationships are set forth in the appended claims.

We claim:

1. Apparatus comprising:

a microwave oven,

wherein the microwave oven includes:

a radiation emitting microwave element,

a microwave housing, wherein the microwave housing bounds a cooking interior area, wherein the radiation emitting microwave element is operative to irradiate the cooking interior area,

wherein an air passage extends between the cooking interior area and an exterior of the housing,

at least one power control circuit, wherein the at least one power control circuit is operative to cause electrical power to be selectively delivered to the microwave element,

wherein the microwave oven further includes at least one sensor emitter and at least one sensor receiver configured to receive radiation from the at least one sensor emitter, wherein the at least one sensor emitter and the at least one sensor receiver extend in the air passage such that air from at least a portion of the cooking interior area extends intermediate of the at least one sensor emitter and the at least one sensor receiver, at least one safety circuit, wherein the at least one safety circuit is in operative connection with the at least one sensor emitter, the at least one sensor receiver, and the microwave element,

wherein the at least one safety circuit is operative to cause

the at least one sensor emitter to emit sensor radiation and the at least one sensor receiver to sense sensor radiation from the at least one sensor emitter while the microwave element operates during a current cooking session,

data to be stored in a memory associated with the at least one safety circuit corresponding to an initial transmissivity level of transmitted radiation from the at least one sensor emitter that reaches the at least one sensor receiver early in the current cooking session,

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comparison of a current level of transmitted radiation during the current cooking session that reaches the at least one sensor receiver, and the initial transmissivity level,

a determination based on the stored data that the current level of transmitted radiation from the at least one sensor emitter that reaches the at least one sensor receiver has fallen by at least a threshold amount from the initial transmissivity level during the current cooking session, due to smoke in the cooking interior area,

responsive at least in part to the determination, the microwave element to no longer be supplied with electrical power to prematurely end the current cooking session,

wherein the at least one safety circuit is configured to reset after the premature end of the current cooking session responsive to the at least one sensor circuit, so that the at least one sensor circuit is operative to cause the radiation emitting microwave element to be allowed to be supplied with electrical power during a next subsequent cooking session.

2. The apparatus according to claim 1

wherein the microwave oven housing includes a fan, wherein the fan is operative to cause air from the cooking interior area to move through the air passage.

3. The apparatus according to claim 1 and further including

a power supply outlet, wherein the power supply outlet is provided on the microwave oven,

wherein the power supply outlet is configured to receive an electrical connection to an appliance having lower power requirements than power requirements of the microwave oven,

wherein the at least one power control circuit is operative to cause

electrical power to be selectively delivered to the microwave element and the power supply outlet, wherein the power supply outlet does not operate to supply power therefrom when the microwave element draws cooking power.

4. The apparatus according to claim 1 and further comprising:

a power supply outlet provided on the microwave oven wherein the power supply outlet is in operative connection with the at least one power control circuit,

a refrigerator configured to be connected to the power supply outlet,

wherein the refrigerator includes a refrigerator housing, wherein the refrigerator housing bounds a cooled refrigerator interior area, wherein the refrigerator housing is in a fixed operative connection with the microwave housing, wherein the refrigerator includes a refrigerant compressor, wherein the refrigerant compressor is operative to compress refrigerant material, wherein the refrigerant is operative to cause cooling of the cooled refrigerator interior area,

wherein the at least one power control circuit is configured to:

disable refrigerator operation by not supplying electrical power to the compressor when the microwave element draws cooking power;

enable refrigeration operation by supplying electrical power to the compressor when the microwave element does not draw cooking power.

5. The apparatus according to claim 4

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wherein the microwave oven includes a USB port,
wherein the USB port is in operative connection with
the at least one power control circuit,

wherein the USB port is not operative when the microwave element draws cooking power.

6. The apparatus according to claim 4

wherein the microwave oven includes an inductance charging pad, wherein the inductance charging pad is in operative connection with the at least one power control circuit,

wherein the inductance charging pad is not operative when the microwave element draws cooking power.

7. The apparatus according to claim 4 and further including

a wireless interface, wherein the wireless interface is in operative connection with the at least one power control circuit,

wherein the wireless interface is operative to transmit signals indicative of a condition of at least one of the microwave oven and the refrigerator, to a wireless mobile device.

8. The apparatus according to claim 4 and further including

a temperature sensor, wherein the temperature sensor is operative to sense a temperature corresponding to temperature in the cooking interior area,

wherein the temperature sensor is in operative connection with the at least one safety circuit,

wherein the at least one power control circuit is operative to cause the microwave element to no longer be supplied with cooking power to prematurely end the current cooking session responsive at least in part to the determination, and

the temperature being sensed above a temperature level during the current cooking session.

9. Apparatus comprising:

a microwave oven configured to be connected to a source of electrical power and having a control circuit, wherein the control circuit is configured to control operation of the microwave oven;

a smoke sensor, wherein the smoke sensor is positioned in an air passage that extends between a cooking area inside the microwave oven and air outside the microwave oven, wherein the smoke sensor is in operative connection with the control circuit, wherein the smoke sensor is configured to cause cooking power to the microwave oven to be withdrawn prior to a set end time of a current cooking session upon the smoke sensor sensing smoke indicative of a dangerous condition; and wherein the smoke sensor is configured to be reset after ending the current cooking session prior to the set end time based on sensing the smoke indicative of the dangerous condition, to enable the microwave oven to receive cooking power in a next subsequent cooking session responsive at least in part to the smoke sensor no longer sensing the smoke indicative of the dangerous condition.

10. The apparatus according to claim 9 and further comprising:

a power supply outlet on the microwave oven, wherein the power supply outlet is in operative connection with the control circuit,

a refrigerator, wherein the refrigerator is electrically connected with the power supply outlet,

wherein the control circuit is operative to

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withdraw electrical power from the refrigerator when the microwave oven draws cooking power,

deliver electrical power to the refrigerator when the microwave oven does not draw cooking power.

11. The apparatus according to claim 10, wherein the smoke sensor includes at least one of

a photosensor,

a motion sensor,

an ionization sensor,

a VOC sensor,

a sensor including a radiation emitter and a radiation receiver.

12. The apparatus according to claim 10

wherein the microwave oven includes a USB port, wherein the USB port is in operative connection with the control circuit,

wherein the control circuit causes the USB port not to be operative when the microwave oven draws cooking power.

13. The apparatus according to claim 10

wherein the microwave oven includes an inductance charging pad,

wherein the inductance charging pad is in operative connection with the control circuit,

wherein the control circuit causes the inductance charging pad not to be operative when the microwave oven draws cooking power.

14. The apparatus according to claim 10

and further including a wireless interface, wherein the wireless interface is in operative connection with the control circuit,

wherein the wireless interface is operative to transmit signals indicative of a condition of at least one of the microwave oven and the refrigerator to a wireless mobile device.

15. The apparatus according to claim 10 and further including

a temperature sensor, wherein the temperature sensor is operative to sense a temperature corresponding to temperature in the cooking area,

wherein the temperature sensor is in operative connection with the smoke sensor,

wherein the control circuit is operative to cause cooking power to the microwave oven to be withdrawn prior to the set end time of the current cooking session, responsive to the smoke sensor sensing smoke indicative of the dangerous condition and the temperature being sensed above a temperature level during the cooking session.

16. The apparatus according to claim 10

wherein the smoke sensor includes a sensor emitter and a sensor receiver, wherein the sensor receiver is configured to receive radiation output from the sensor emitter,

a sensor circuit, wherein the sensor circuit is in operative connection with the sensor emitter, the sensor receiver and the control circuit,

wherein the sensor circuit is operative to cause the sensor emitter to emit radiation and the sensor receiver to sense radiation from the sensor emitter while the microwave oven operates during a current cooking session,

data to be stored in a memory associated with the sensor circuit corresponding to an initial transmissivity level of transmitted radiation from the sensor emitter that reaches the sensor receiver early in the current cooking session.

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comparison of a current level of transmitted radiation that reaches the sensor receiver during the current cooking session, and the initial transmissivity level, a determination based on the stored data, that the current level of transmitted radiation from the sensor emitter that reaches the sensor receiver has fallen by at least a threshold amount from the initial transmissivity level during the current cooking session, wherein the determination corresponds to smoke indicative of the dangerous condition, wherein cooking power to the microwave oven is withdrawn prior to the set end time of the current cooking session responsive at least in part to the determination.

17. Apparatus comprising:

a microwave oven configured to be connected to a source of electrical power and having a control circuit to control operation of the microwave oven, wherein the microwave oven includes an interior cooking area, wherein the microwave oven includes an air passage that extends between the cooking area and outside the microwave oven,

a smoke sensor, wherein the smoke sensor is positioned in the air passage, wherein the smoke sensor is configured to cause cooking power to be withdrawn from the microwave oven prior to a set end time of a current cooking session responsive at least in part to the smoke sensor sensing at least one change in an amount of smoke sensed by the smoke sensor, which at least one change corresponds to a dangerous condition, and wherein the control circuit is configured to reset after ending the current cooking session prior to the set end time due to sensing the dangerous condition, to enable cooking power to again be available to the microwave

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oven in a next subsequent cooking session responsive at least in part to the smoke sensor no longer sensing the dangerous condition.

18. The apparatus according to claim 17 and further comprising:

a power supply outlet on the microwave oven, a refrigerator configured to be connected to the source of electrical power by connection to the power supply outlet, wherein the refrigerator includes a compressor, wherein the control circuit is operative to cause electrical power to be unavailable to the compressor, when the microwave oven demands cooking power, electrical power to be available to the compressor when the microwave oven does not demand cooking power.

19. The apparatus according to claim 18, wherein the smoke sensor includes at least one of

a radiation emitter and radiation receiver, a photosensor, a motion sensor, an ionization sensor, a VOC sensor.

20. The apparatus according claim 18, wherein the microwave oven further includes at least one output device including at least one of

a USB port, an inductance charging pad, an auxiliary electrical outlet,

wherein the at least one output device is in operative connection with the control circuit, and wherein the control circuit is operative to cause the at least one output device to be inoperative when the microwave oven demands cooking power.

* * * * *

EXHIBIT

US Patent No. 11,677,777



US011674745B2

(12) **United States Patent**
Hall et al.

(10) **Patent No.:** **US 11,674,745 B2**

(45) **Date of Patent:** **Jun. 13, 2023**

(54) **MULTIPLE LINKED APPLIANCE WITH
AUXILIARY OUTLET**

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Dennis O'Brien, Guelph (CA)

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(65) **Prior Publication Data**

US 2022/0163255 A1 May 26, 2022

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Nov. 1, 2019, now Pat. No. 11,274,876, which is a
(Continued)

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F25D 23/12 (2006.01)
H05B 6/68 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **F25D 23/12** (2013.01); **F25D 29/005**
(2013.01); **H05B 6/666** (2013.01); **H05B 6/68**
(2013.01)

(58) **Field of Classification Search**

CPC H05B 6/642; H05B 6/6435; H05B 6/645;
H05B 6/6458; H05B 6/6461;

(Continued)

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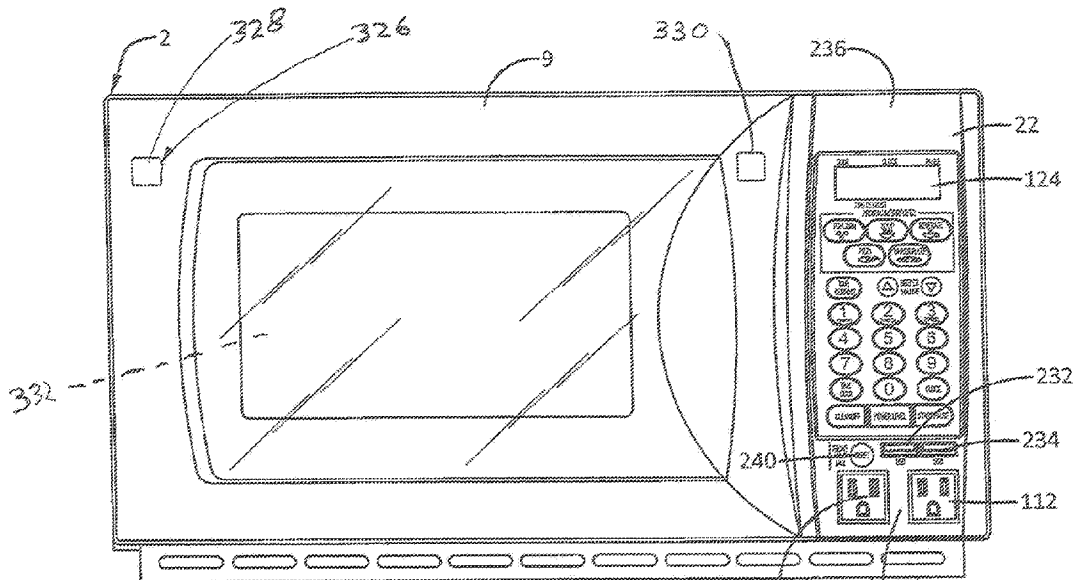
Primary Examiner — Hung D Nguyen

(74) *Attorney, Agent, or Firm* — Ralph E. Jocke; Walker
& Jocke

(57) **ABSTRACT**

A combination microwave and refrigerator system is provided. The microwave oven is connected to a source of power and has a control circuit for controlling the operation of the microwave oven. A first power supply outlet is provided on the microwave oven. A refrigerator is connected to the source of power by connection to the first power supply outlet. The control circuit is configured to disable the cooling operation of the refrigerator, when the microwave oven demands cooking power, and enable the cooling operation of the refrigerator when the microwave oven is not drawing cooking power. A safety sensor is provided in the microwave oven, and is configured to cause cooking power to the microwave oven to be turned off upon the safety sensor sensing a dangerous condition.

28 Claims, 25 Drawing Sheets



Petitioner Ex 1022, Page 179 of 265

Related U.S. Application Data

continuation-in-part of application No. 15/600,118, filed on May 19, 2017, now Pat. No. 10,495,374, and a continuation-in-part of application No. 15/239,378, filed on Aug. 17, 2016, now abandoned, which is a continuation of application No. 15/135,883, filed on Apr. 22, 2016, now Pat. No. 9,664,436, which is a continuation-in-part of application No. 14/262,290, filed on Apr. 25, 2014, now Pat. No. 9,657,974, which is a continuation-in-part of application No. 12/317,632, filed on Dec. 23, 2008, now Pat. No. 8,742,304.

- (60) Provisional application No. 62/262,954, filed on Dec. 4, 2015, provisional application No. 62/211,765, filed on Aug. 29, 2015, provisional application No. 61/009,419, filed on Dec. 28, 2007.

(51) **Int. Cl.**

F25D 29/00 (2006.01)
H05B 6/66 (2006.01)

(58) **Field of Classification Search**

CPC H05B 6/6482; H05B 6/66; H05B 6/666;
H05B 6/68; H05B 6/80; H05B 6/806;
H05B 6/808; F25D 23/003; F25D 23/12;
F25D 29/005; F25D 31/005
USPC 219/482, 483, 485, 488, 678, 679, 695,
219/697, 702, 715, 716, 717, 718, 719,
219/720, 721, 722, 723, 756, 757, 760,
219/761

See application file for complete search history.

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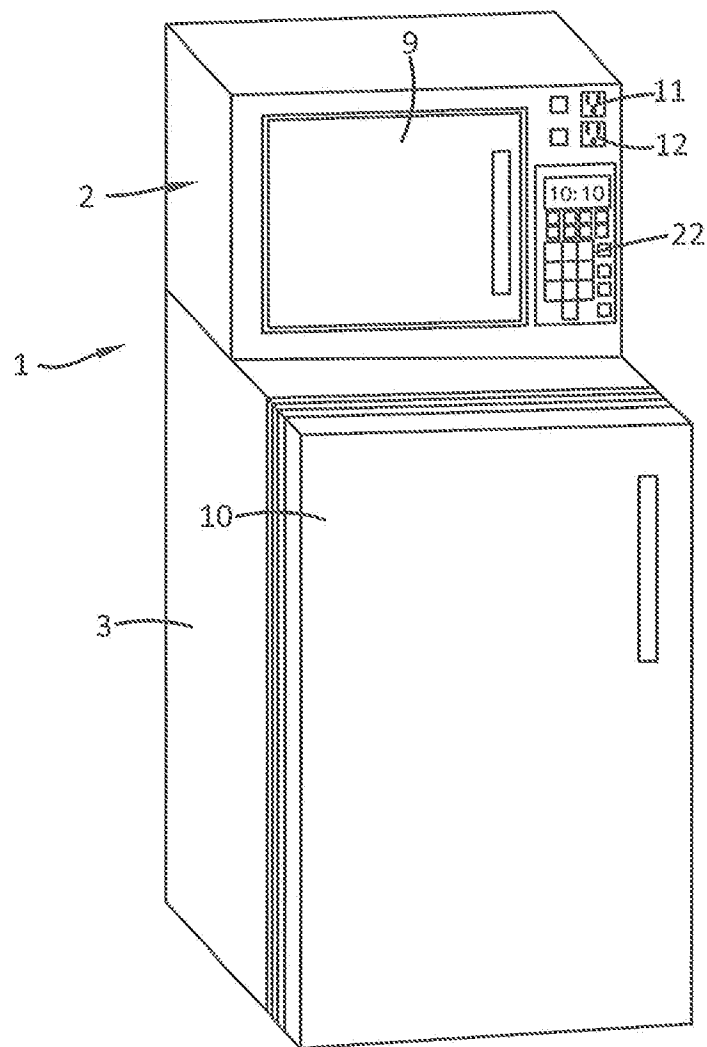


FIGURE 1

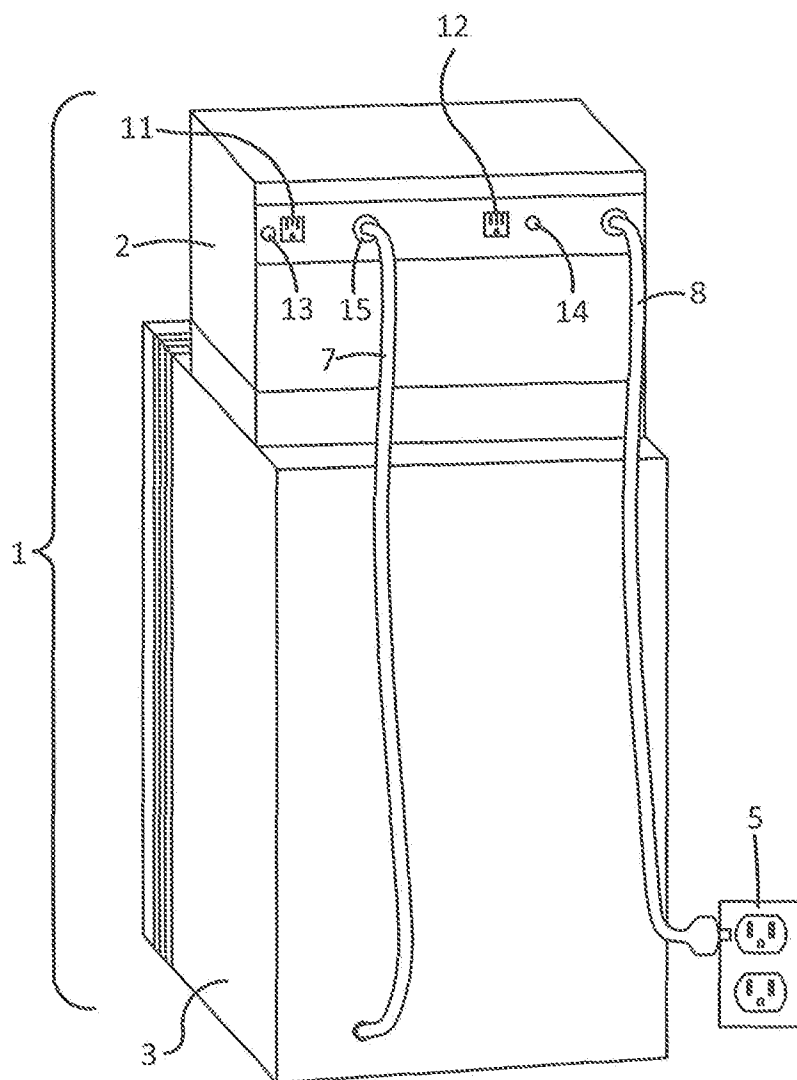


FIGURE 2

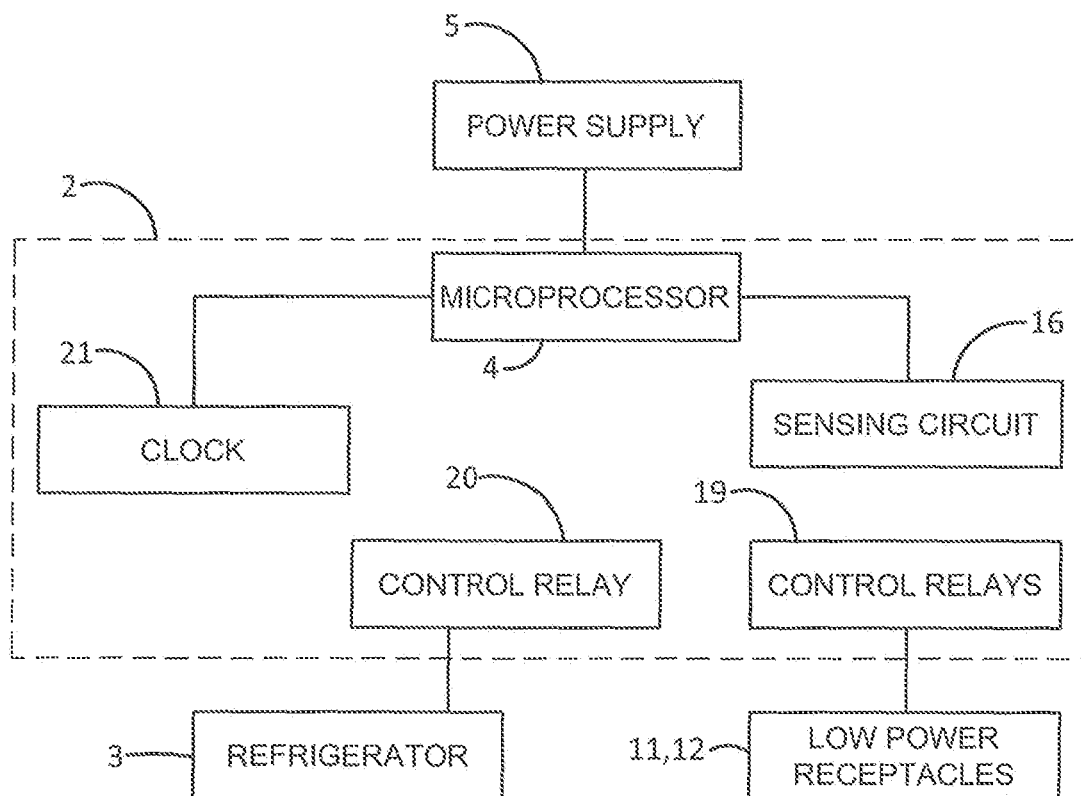


FIGURE 3

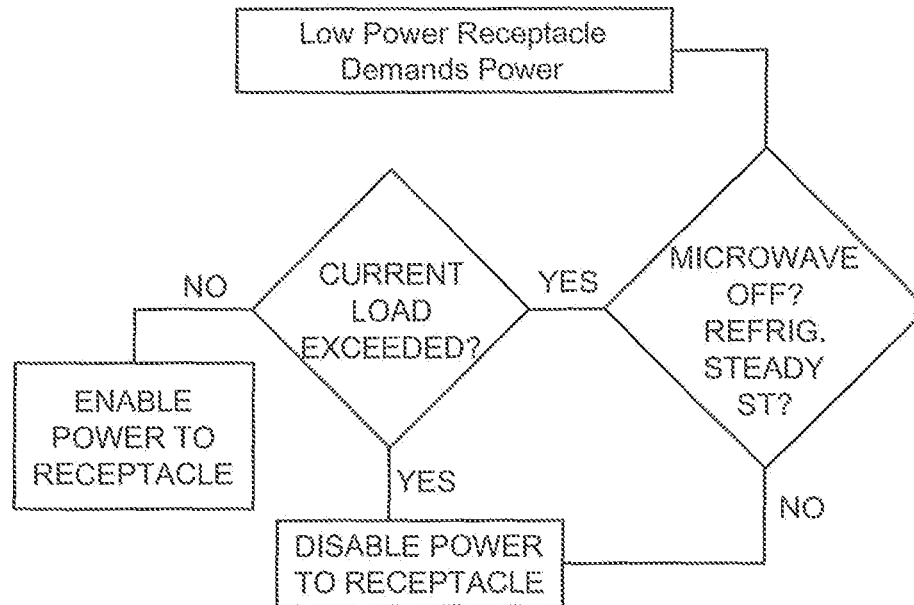


FIGURE 5

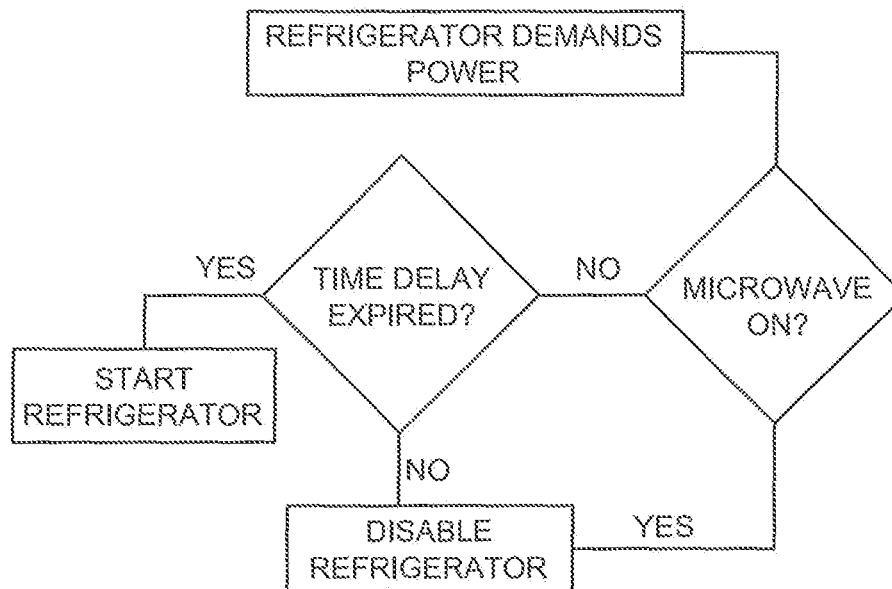


FIGURE 6

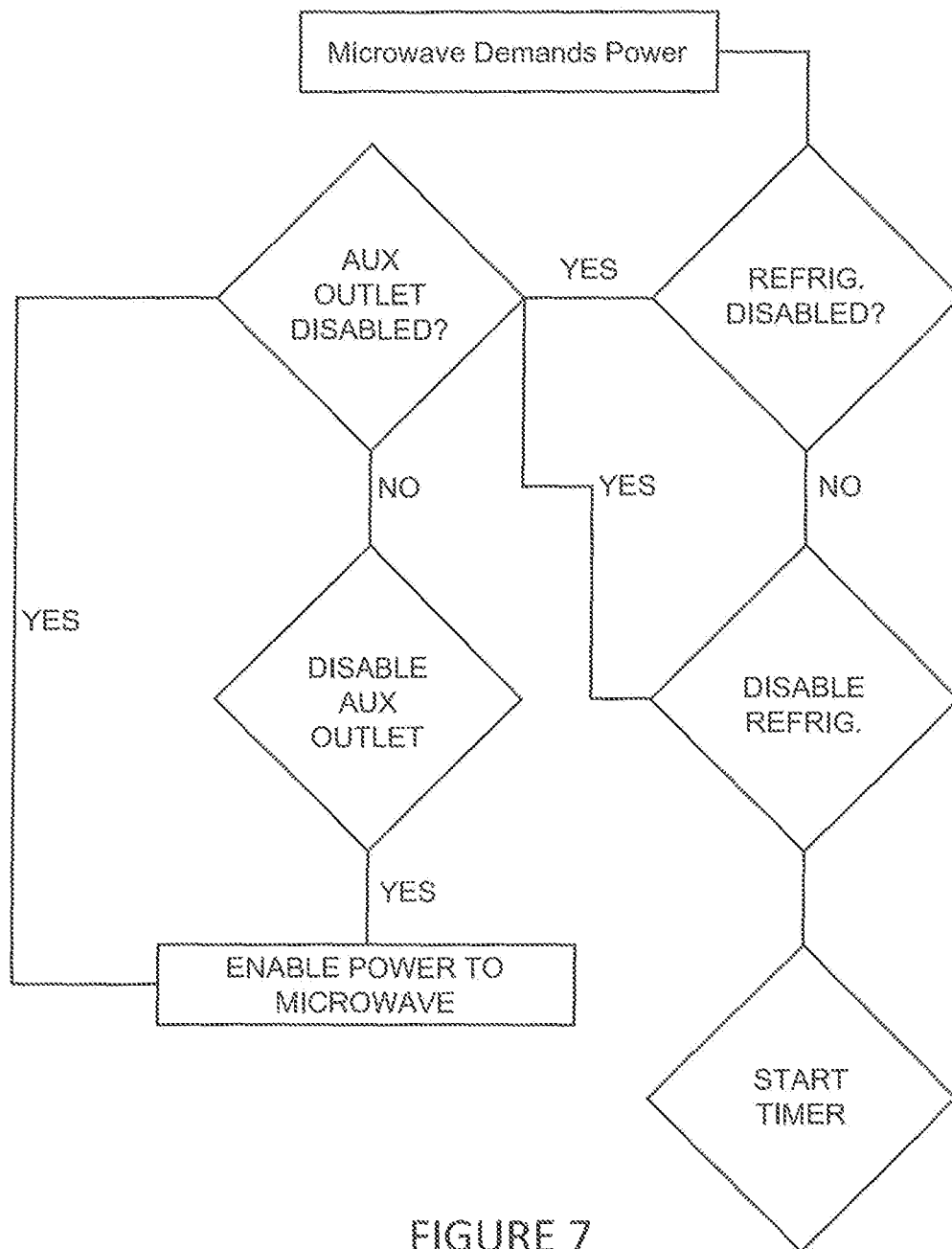


FIGURE 7

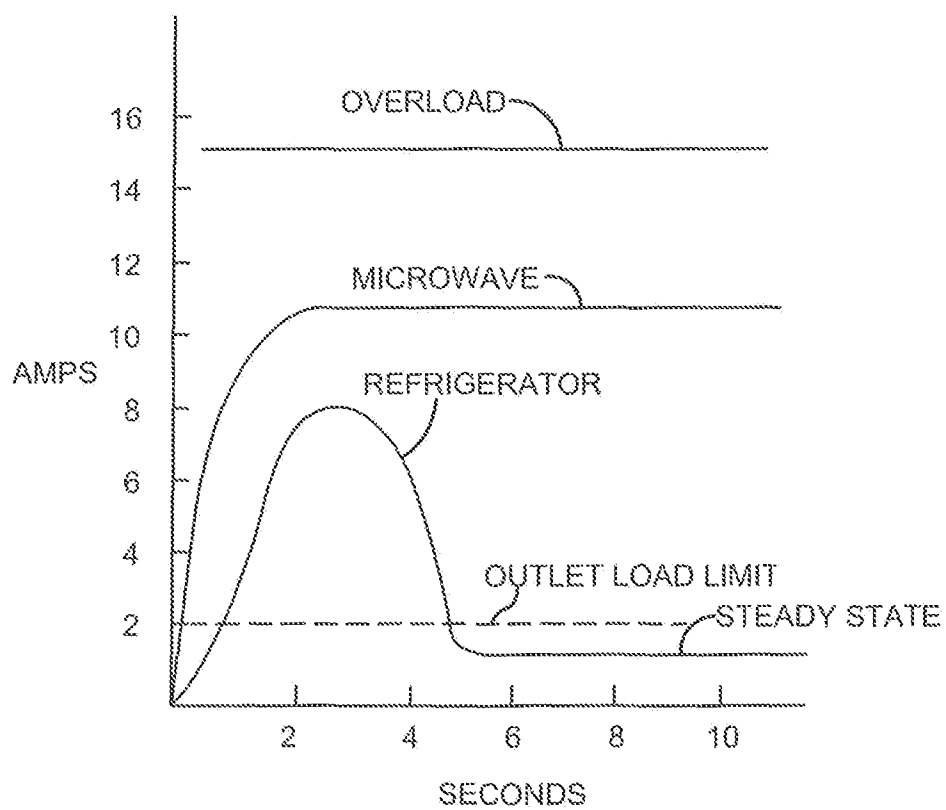


FIGURE 8

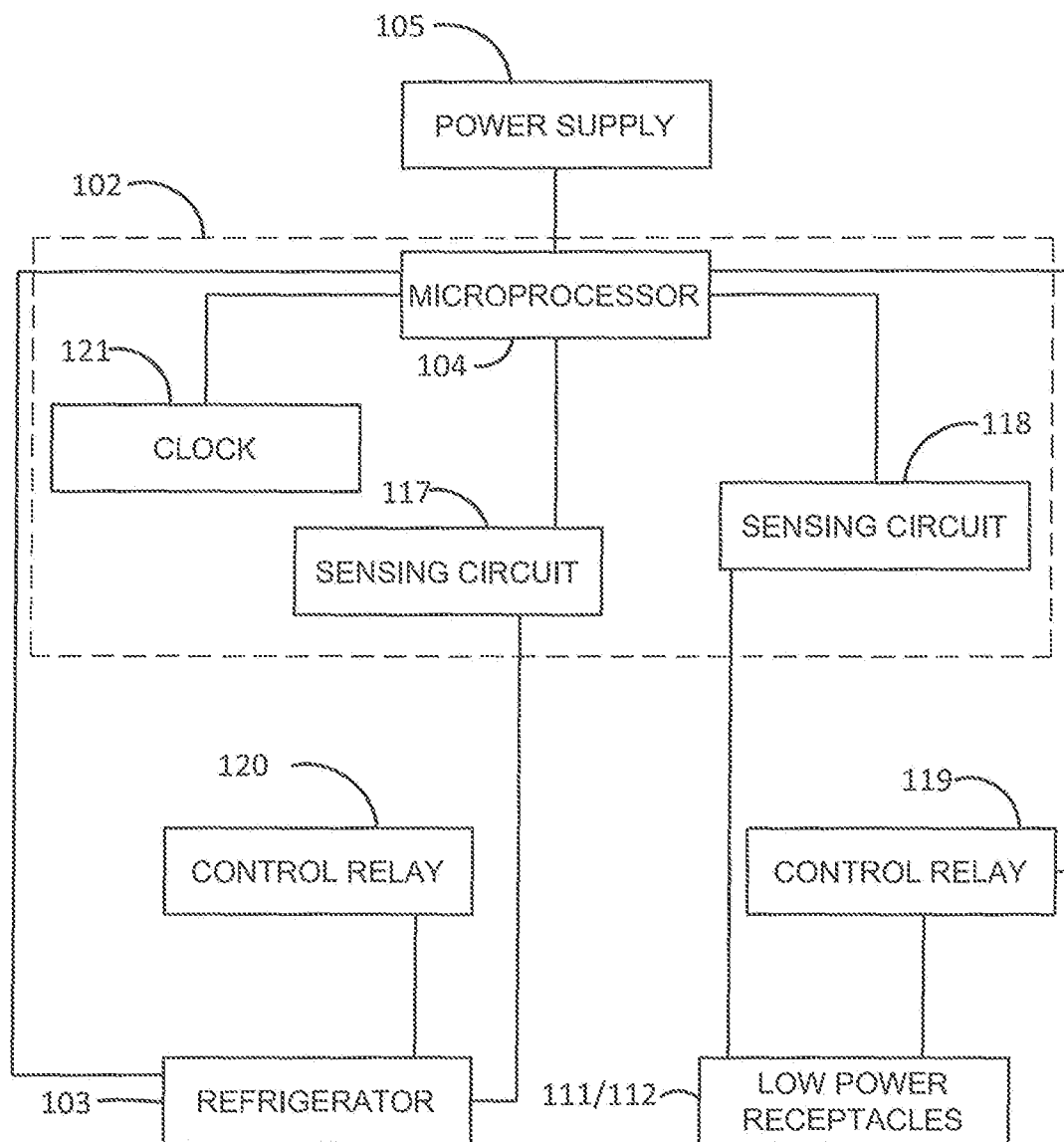


FIGURE 9

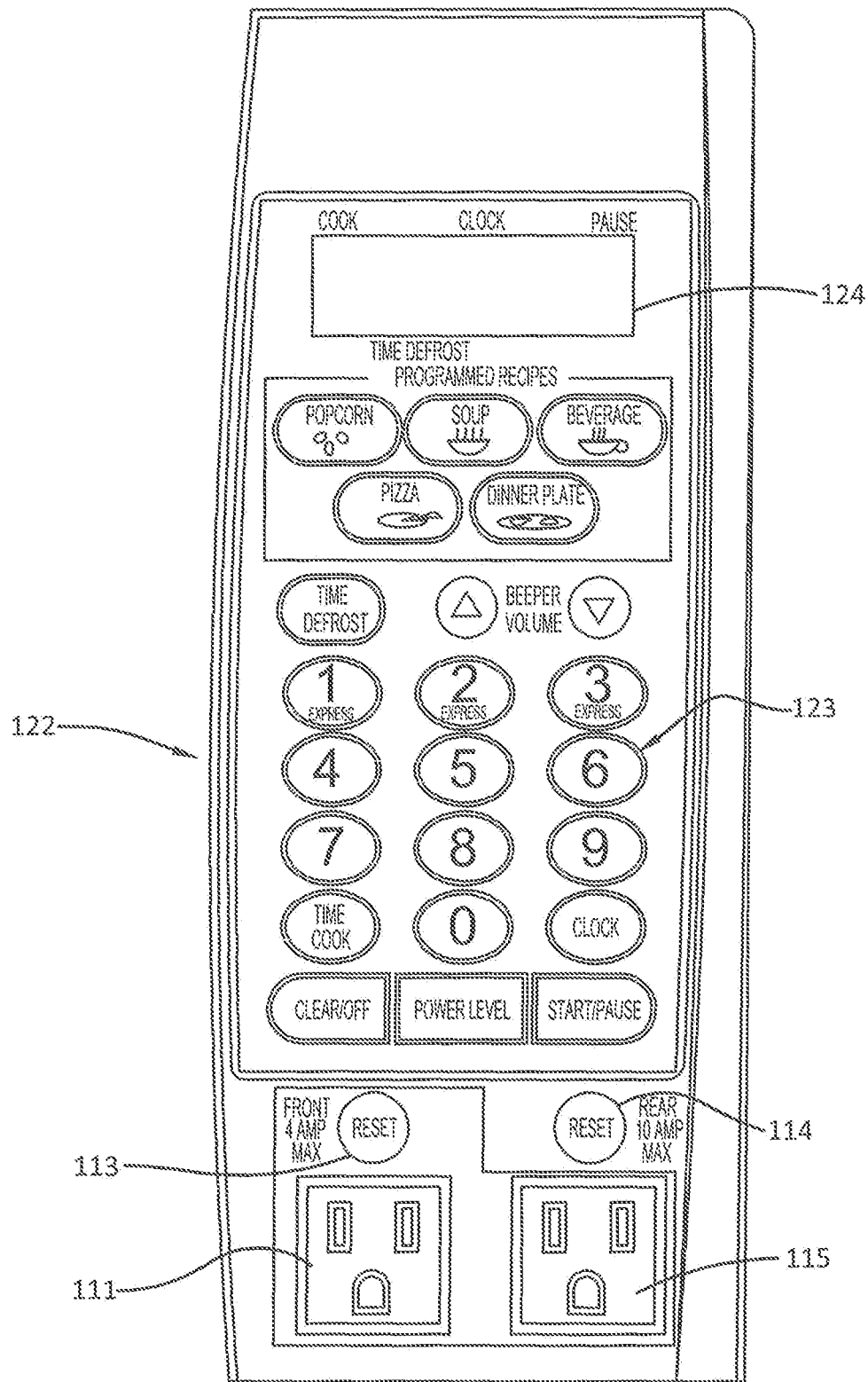


FIGURE 11

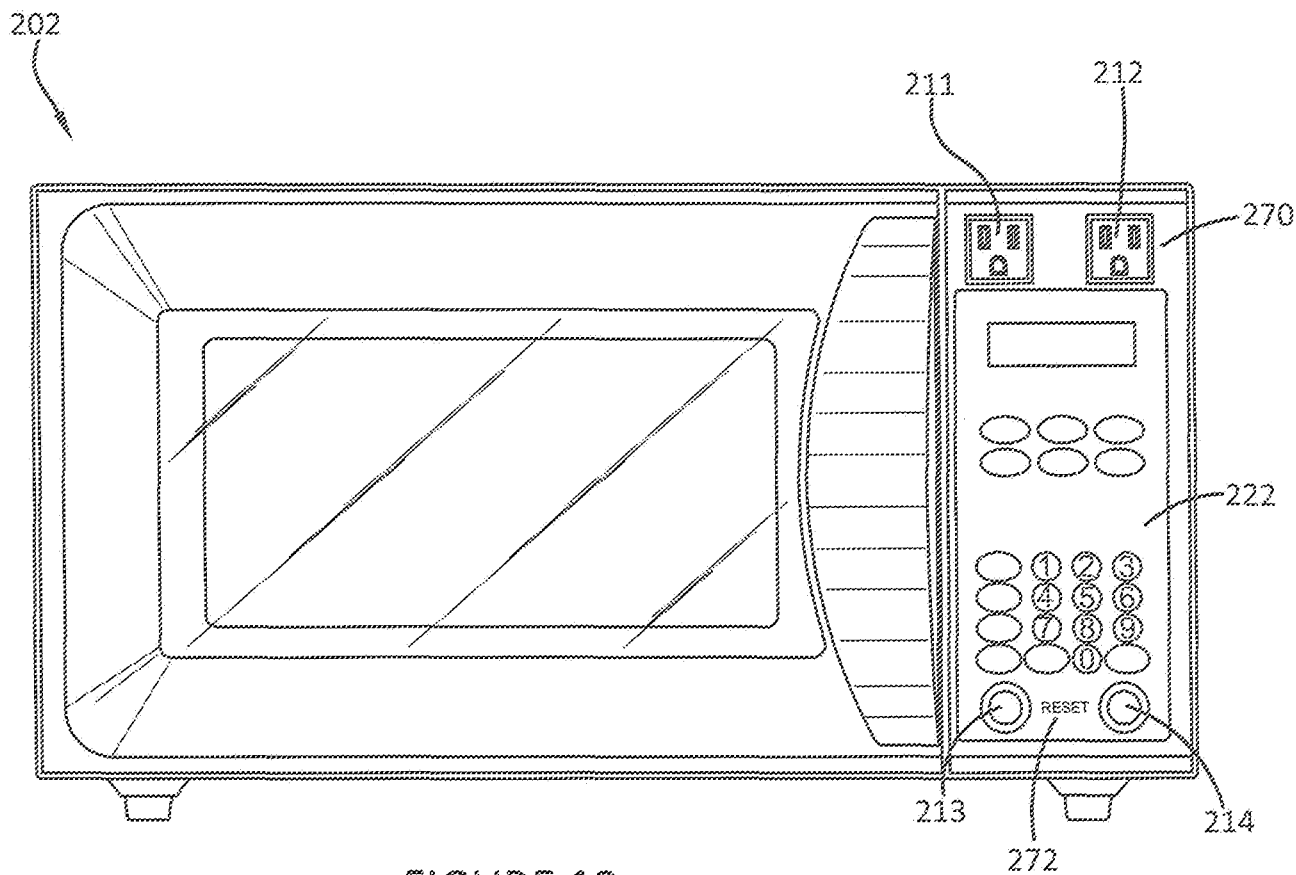


FIGURE 12

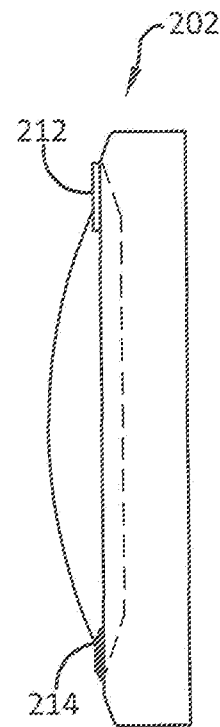


FIGURE 13

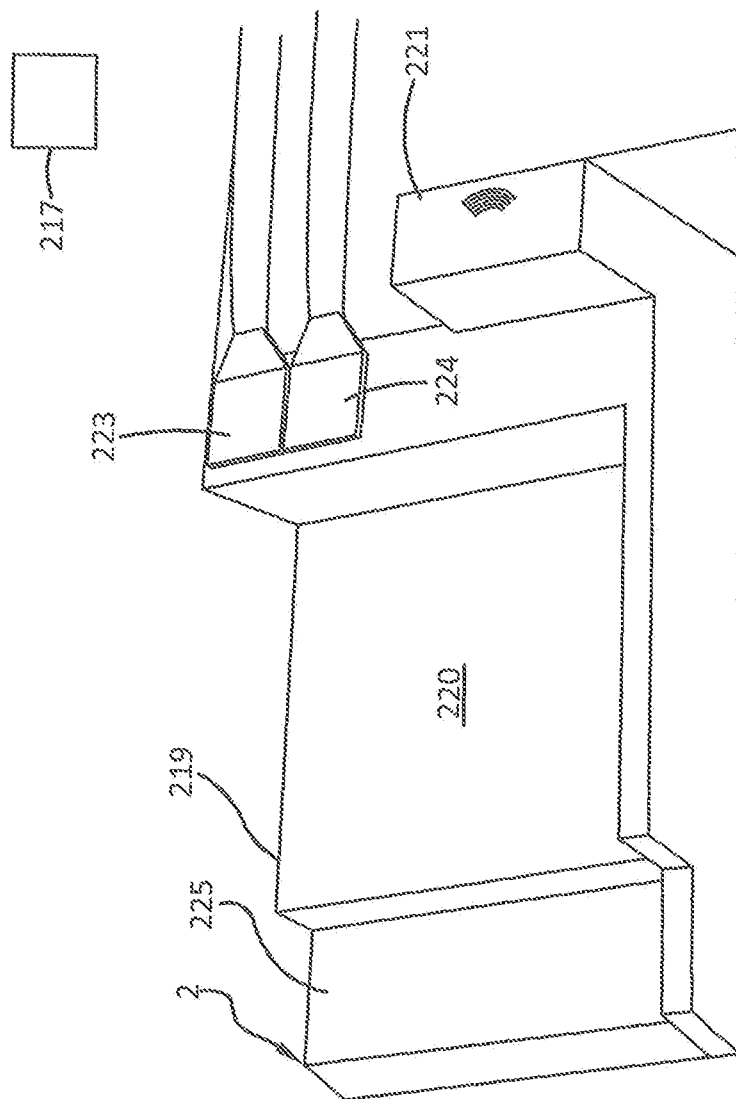
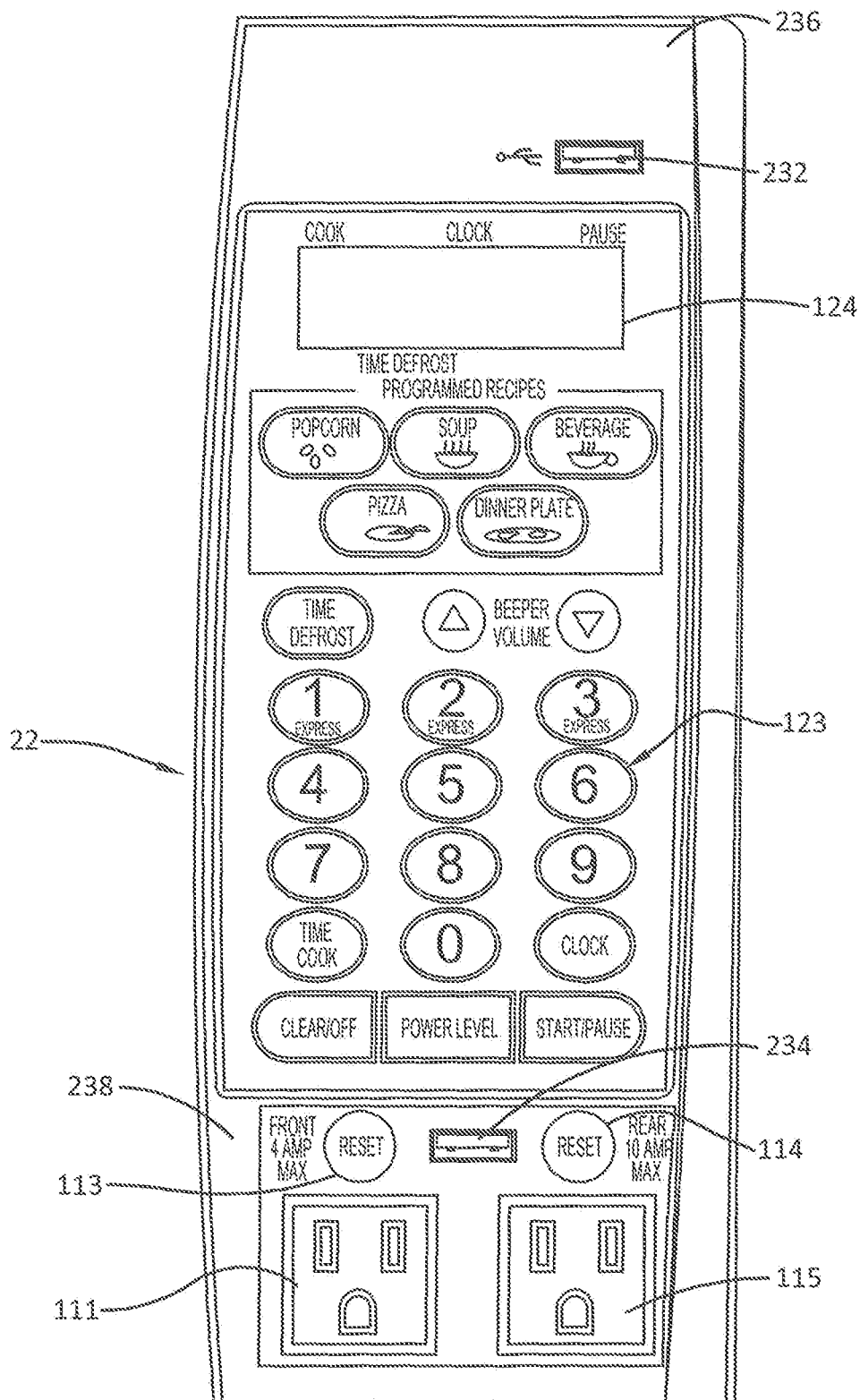


FIGURE 14



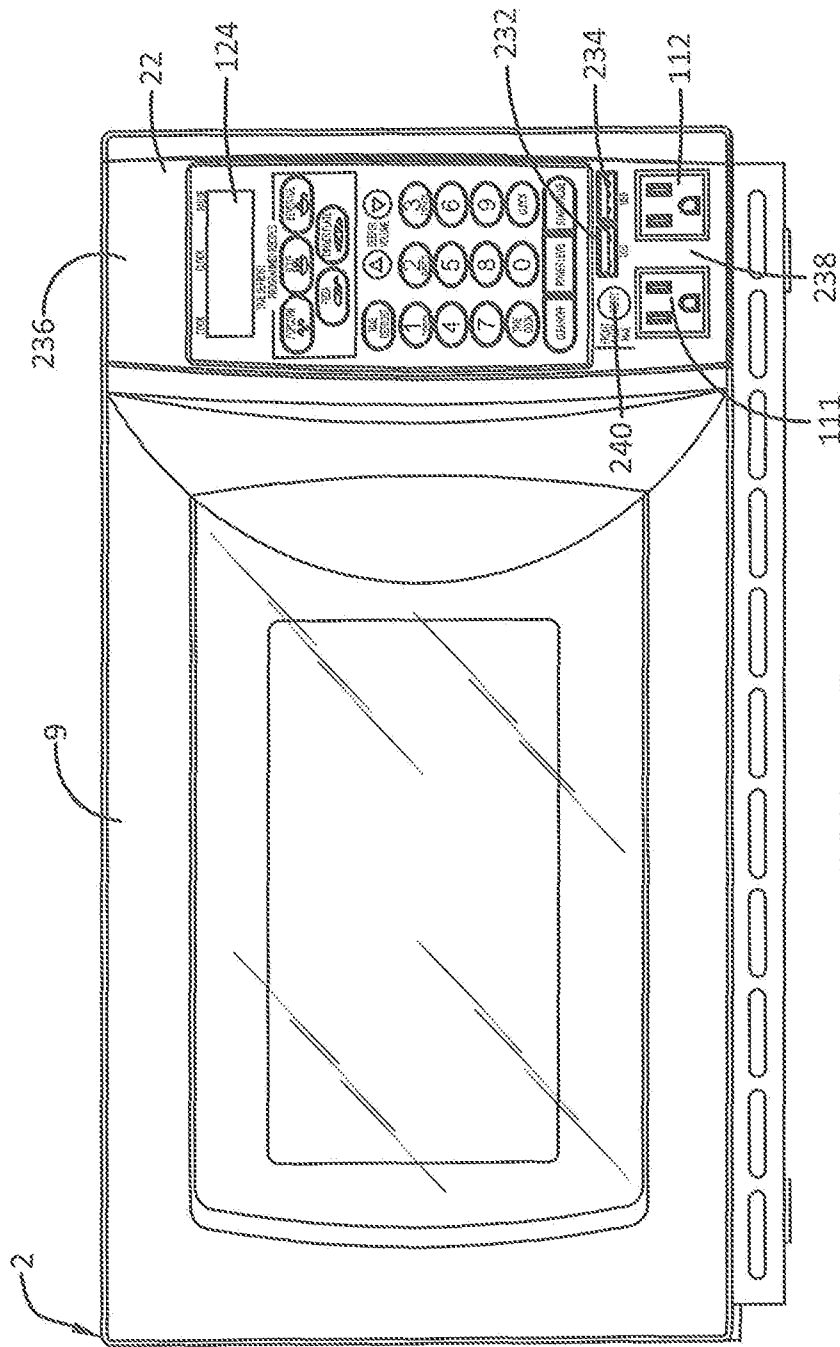


FIGURE 17

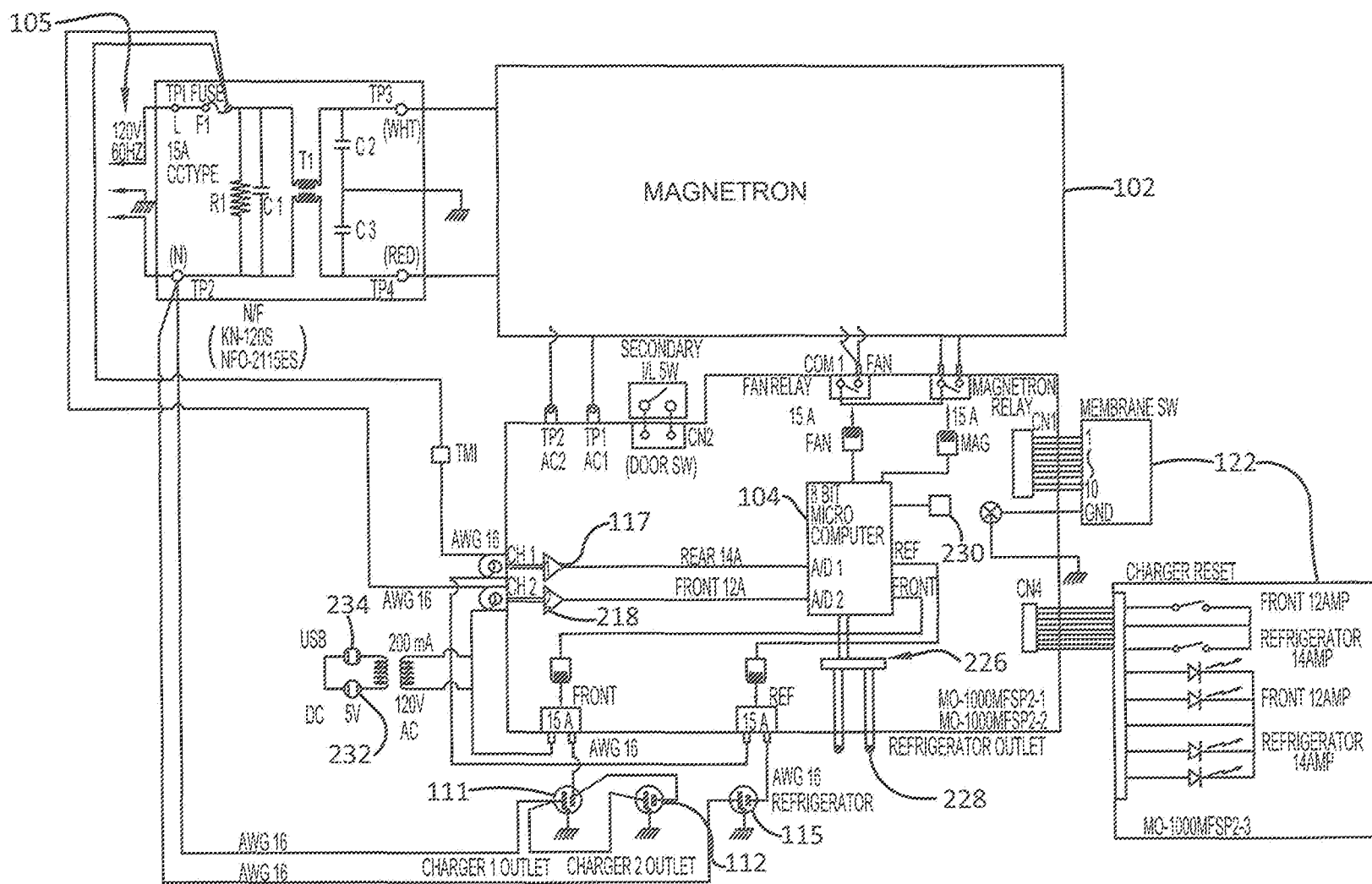


FIGURE 18

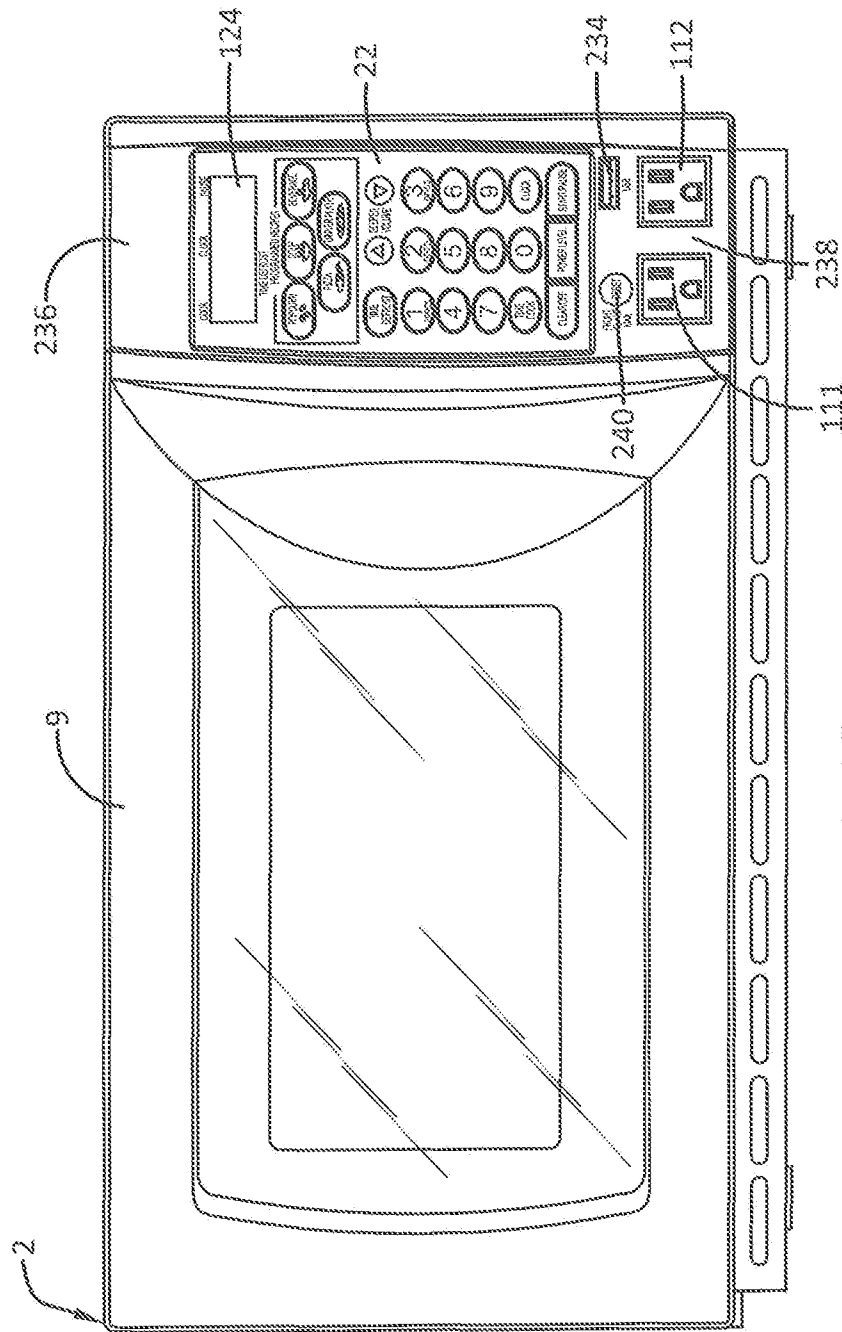


FIGURE 19

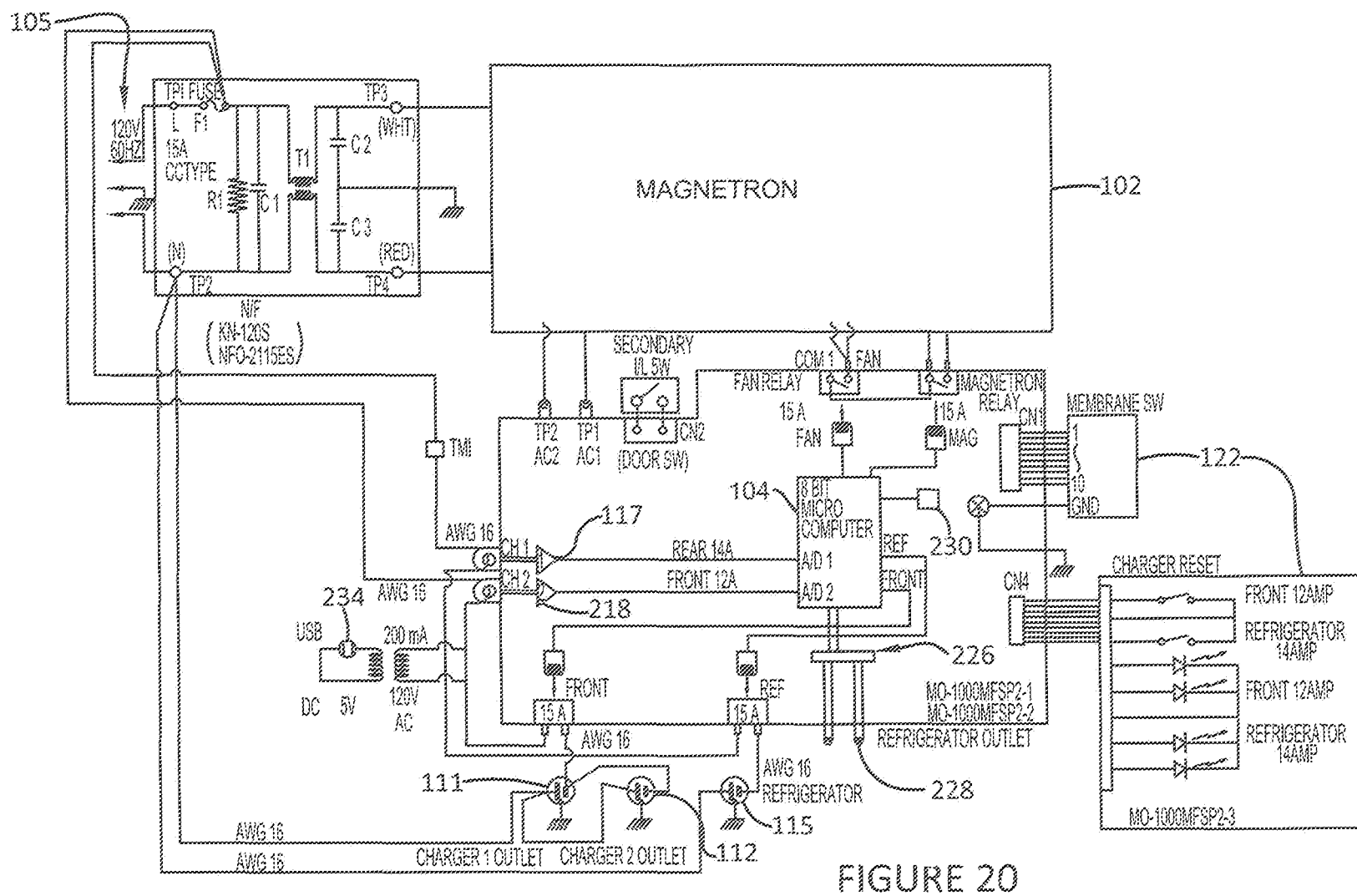


FIGURE 20

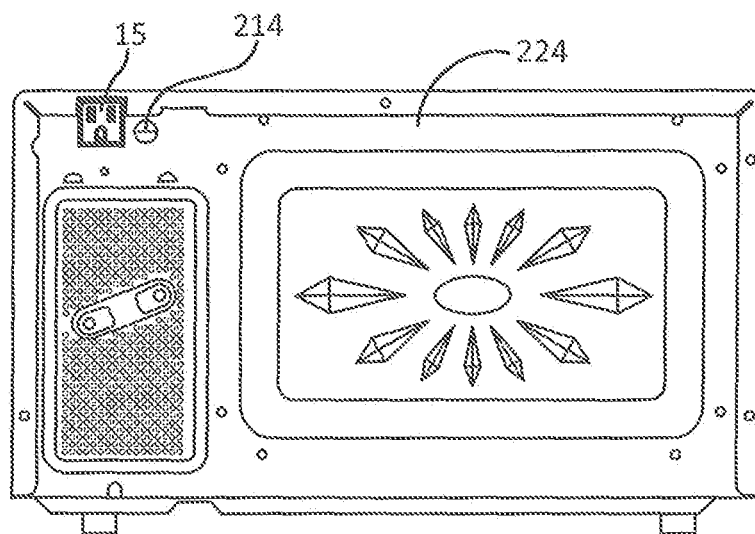


FIGURE 21

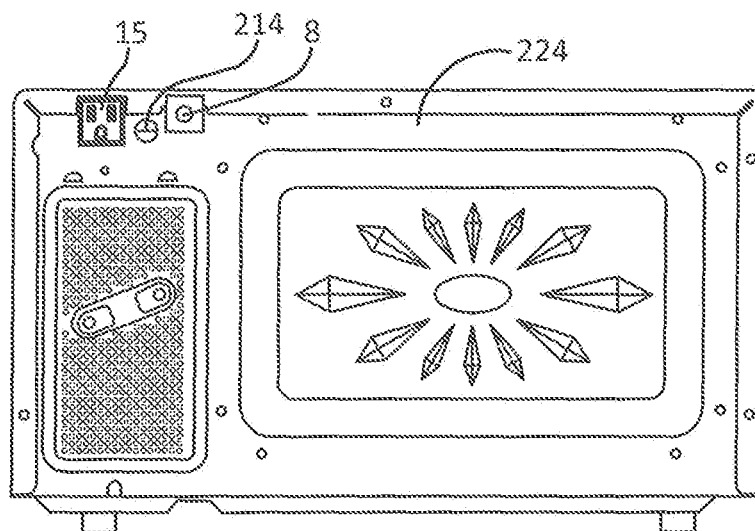


FIGURE 22

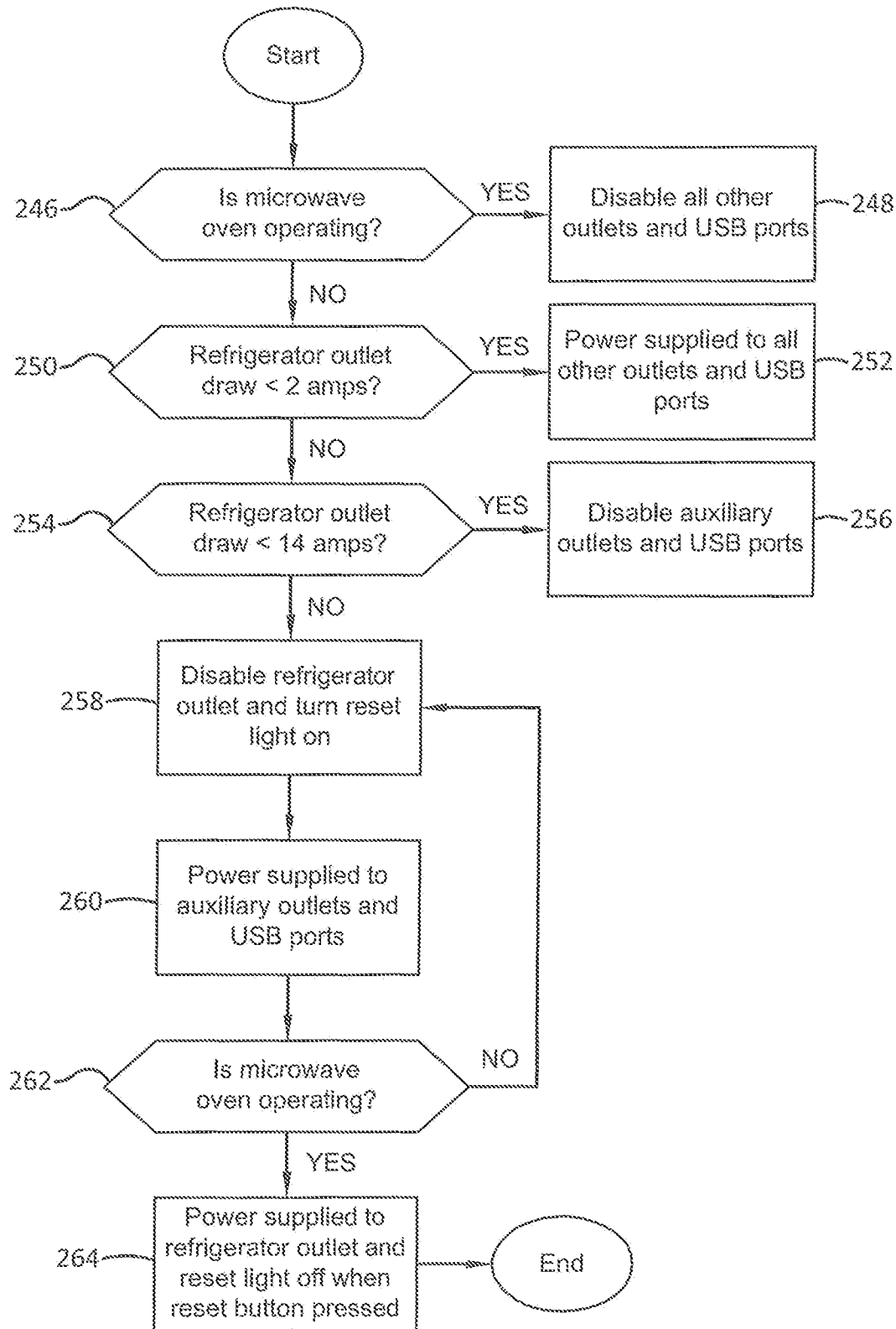
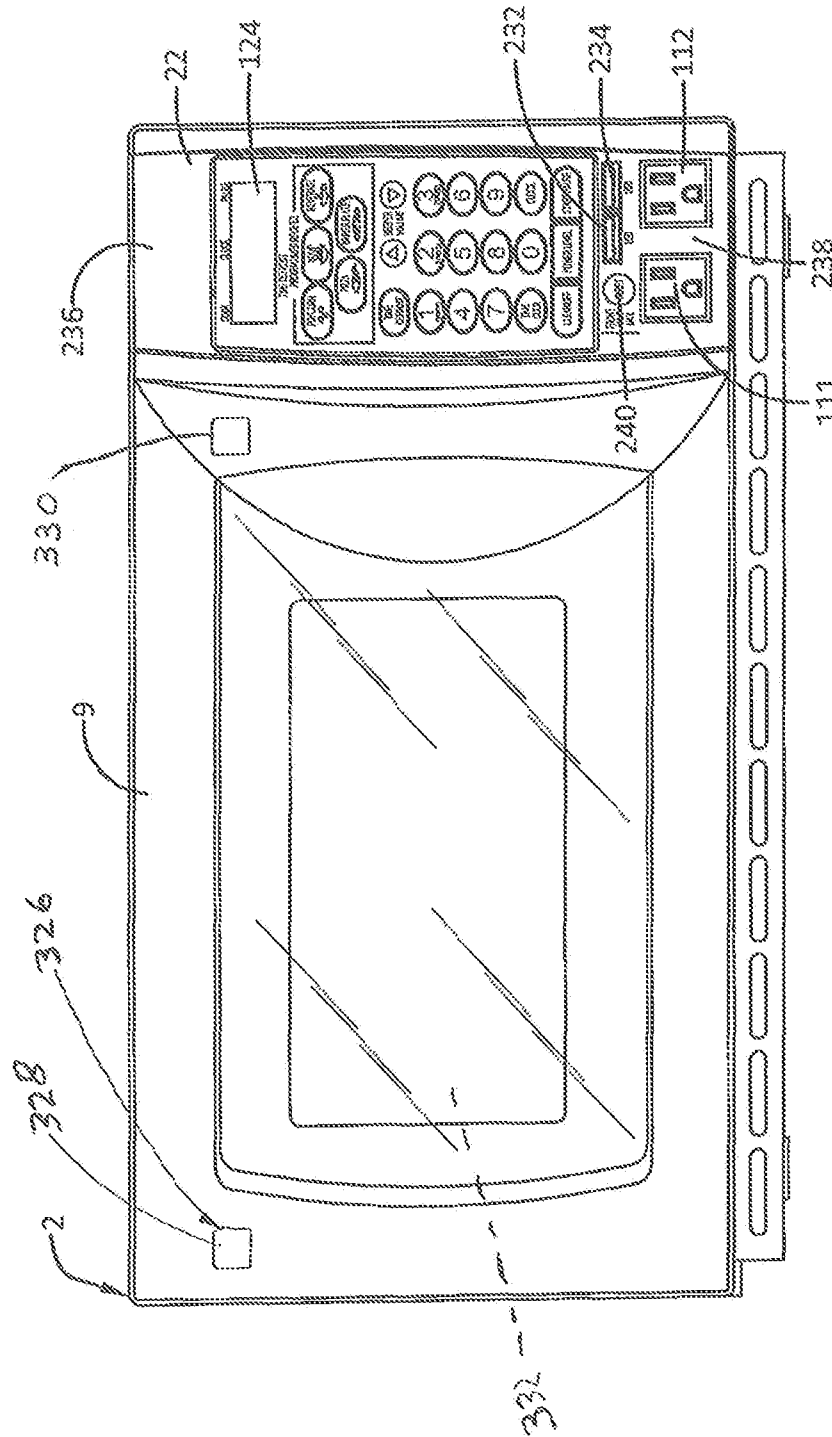
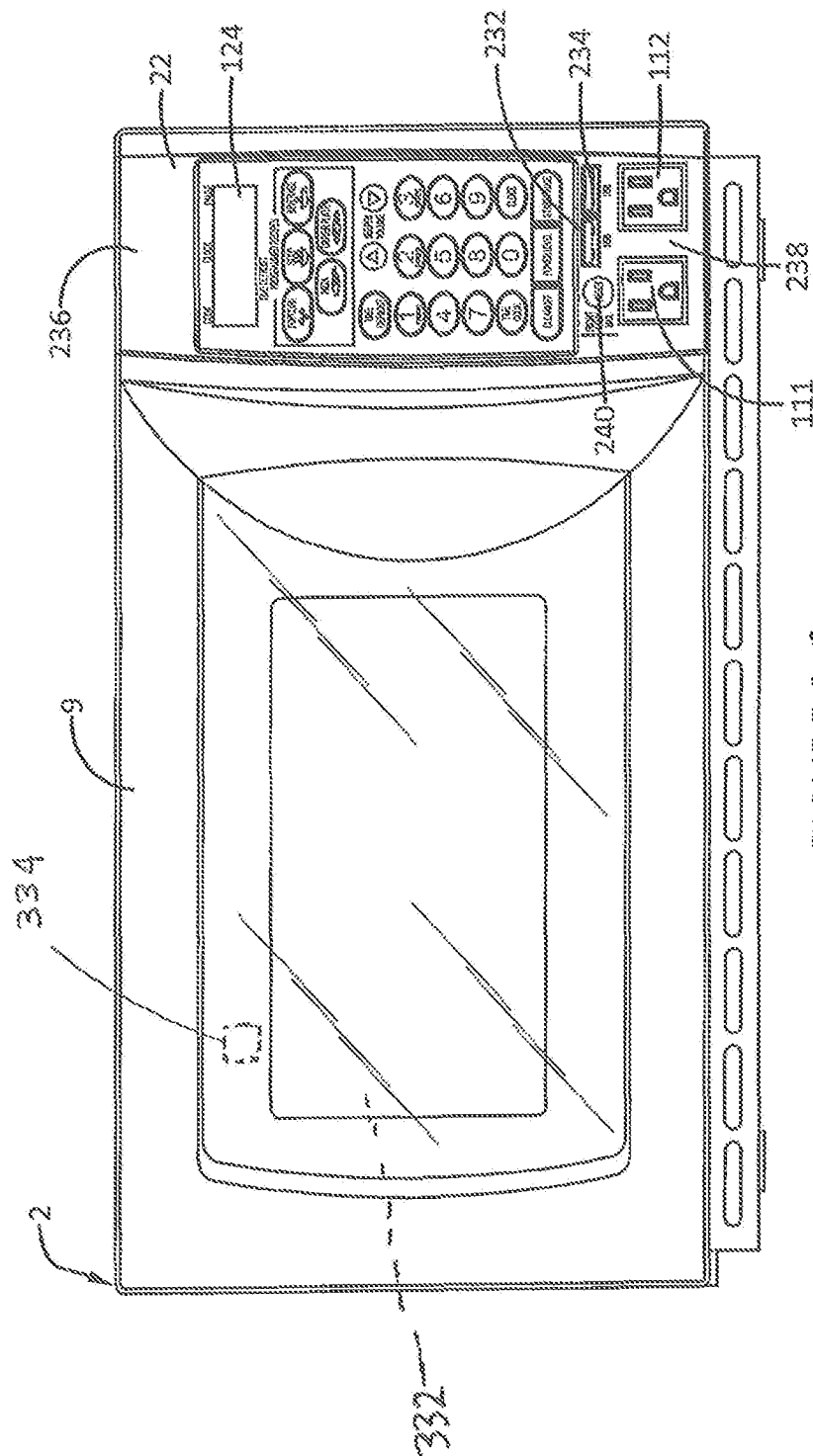
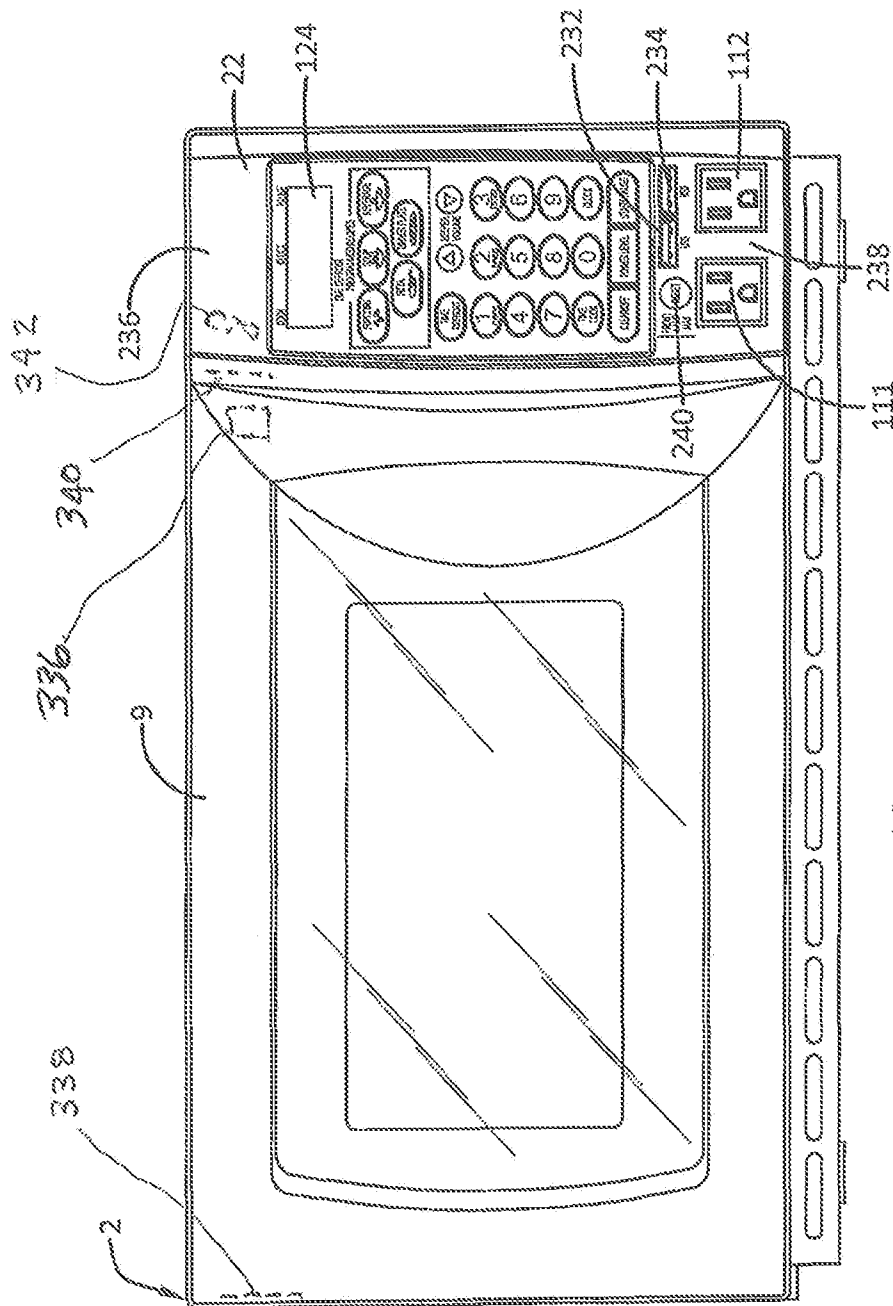


FIGURE 23







SECRET

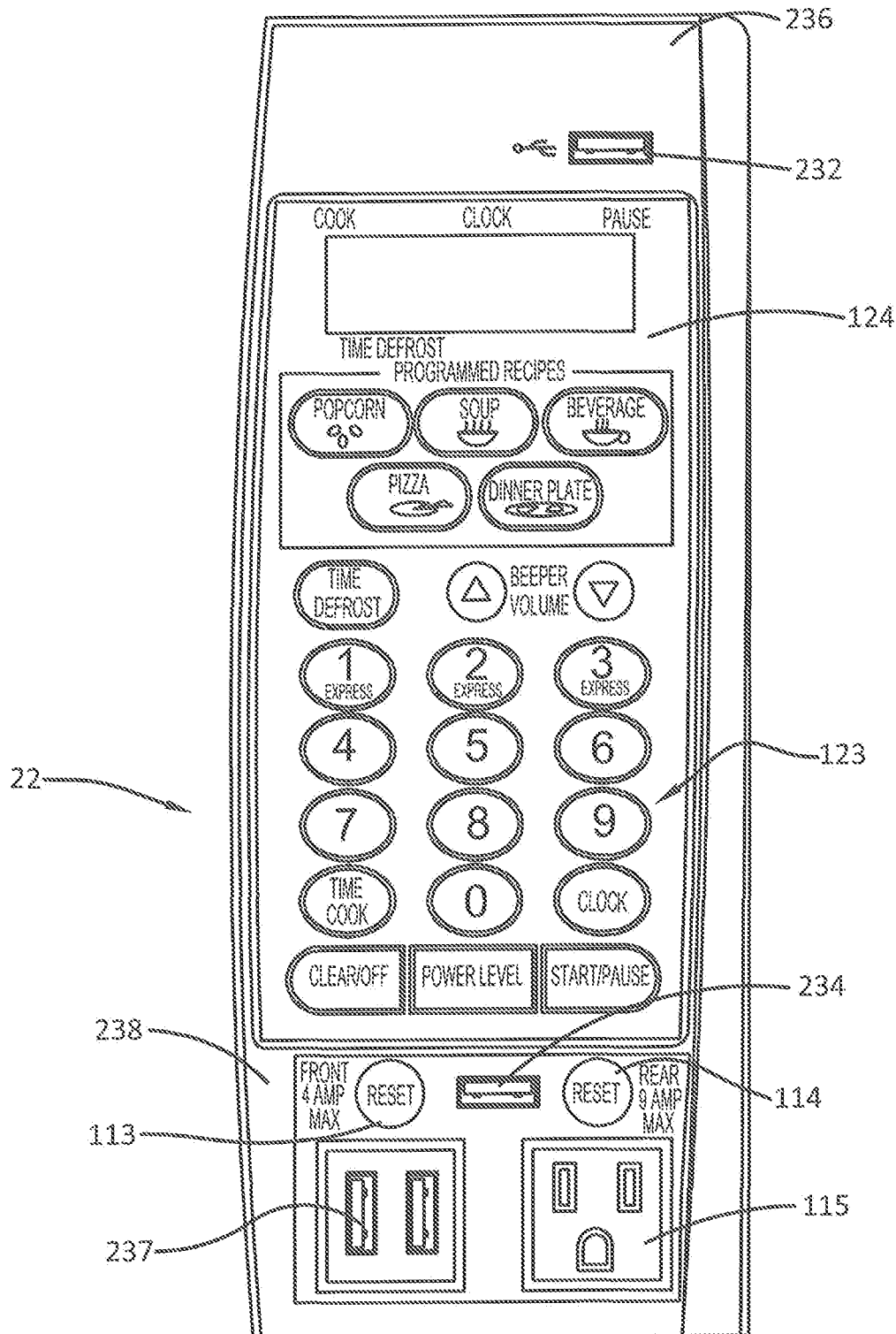


FIGURE 27

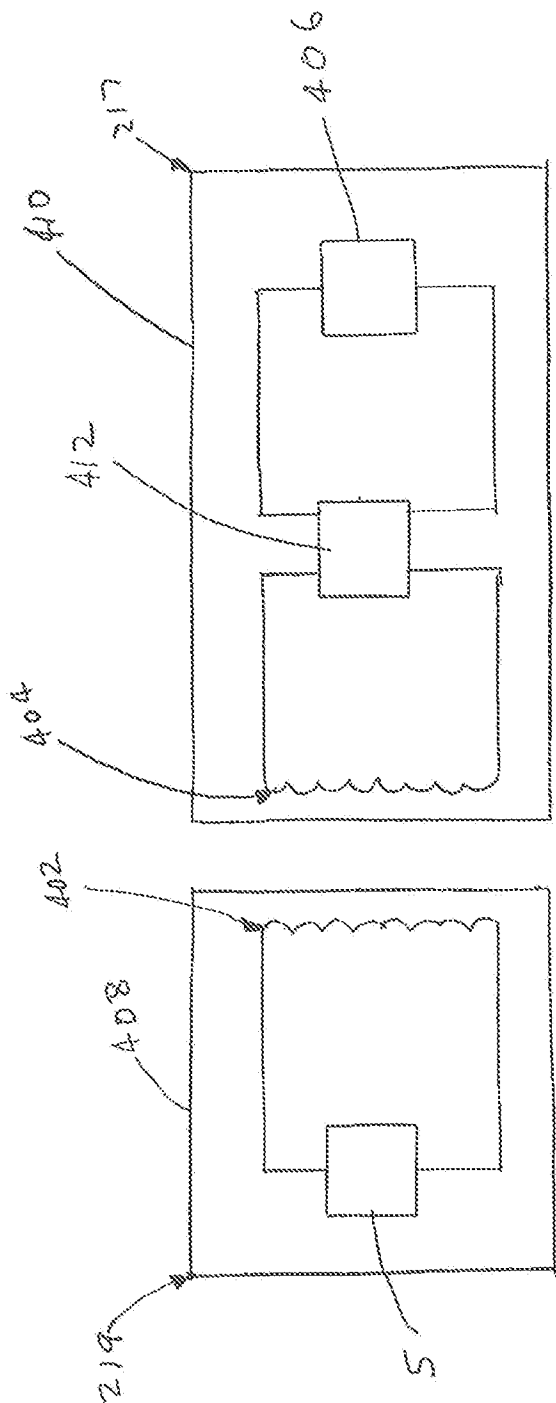


FIGURE 28

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MULTIPLE LINKED APPLIANCE WITH AUXILIARY OUTLET

TECHNICAL FIELD

Exemplary embodiments relate to improvements to appliances. Specifically, exemplary embodiments relate to improvements to appliances that include compact refrigerator and microwave oven functionality.

BACKGROUND

Compact refrigerators are used for many different purposes. They are often found in dormitories, hotels, offices and other establishments. Compact refrigerators are also often used in housing units for storage of beverages in bar areas or entertainment areas. Compact refrigerators provide useful storage for refrigerated items without the requirement for the considerable floor space and power draw that is required for a full size refrigerator.

Compact refrigerators and associated appliances may benefit from improvements.

SUMMARY

In one exemplary arrangement, an appliance apparatus is provided that includes a microwave oven. The microwave oven includes a radiation emitting microwave element and a microwave housing. The microwave housing bounds a cooking interior area. The radiation emitting microwave element is operative to irradiate the cooking interior area. The apparatus also includes a refrigerator. The refrigerator includes refrigerator housing. The refrigerator housing bounds a cooled refrigerator interior area. The refrigerator housing is in fixed operative mechanical connection with the microwave housing. The refrigerator includes a refrigerant compressor, or other refrigeration technology. The refrigerant compressor is operative to compress a refrigerant material. The refrigerant material is operative to cause cooling of the cooled refrigerator interior area. The apparatus includes at least one power control circuit. The at least one power control circuit is operative to cause electrical power to be selectively delivered to the microwave element and the compressor. One of the microwave element and compressor does not operate when the other of the microwave element and the compressor operates. A charging pad is provided on the microwave oven. The charging pad is configured for receiving an item to be charged by the charging pad. The microwave oven further includes at least one smoke sensor. In exemplary arrangements different types of smoke sensors may be used. An exemplary sensor includes a sensor emitter and at least one sensor receiver configured to receive radiation from the at least one smoke sensor emitter, wherein air of at least a portion of the cooking interior area extends intermediate of the at least one sensor emitter and the at least one sensor receiver. The apparatus also includes at least one safety circuit. The at least one safety circuit is in operative connection with the at least one sensor emitter, the at least one sensor receiver, and the microwave element. The at least one safety circuit is operative to cause the at least one sensor emitter to emit sensor radiation and the at least one sensor receiver to sense sensor radiation from the at least one sensor emitter while the microwave element operates during a cooking session. A determination is made that a transmission amount of sensor radiation from the at least one sensor emitter that reaches the at least one sensor receiver has fallen by at least a threshold amount during the cooking session,

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due to smoke in the cooking interior area. Responsive at least in part to the determination, the microwave element is no longer supplied with electrical power.

Other features may be included in exemplary arrangements.

BRIEF DESCRIPTION OF THE DRAWINGS

The system of the application is explained in more detail below with reference to the accompanying drawings, in which:

FIG. 1 is a front perspective view of an exemplary arrangement of an appliance system.

FIG. 2 is a rear perspective view of the arrangement of FIG. 1 showing an alternative arrangement.

FIG. 3 is a schematic block diagram of an arrangement of the exemplary system.

FIG. 4 is an electrical schematic diagram corresponding to the arrangement of FIG. 3.

FIG. 5 is a schematic logic flow diagram of an exemplary arrangement.

FIG. 6 is a schematic logic flow diagram of another exemplary arrangement.

FIG. 7 is a schematic logic flow diagram of another arrangement.

FIG. 8 is a graph illustrating the duty cycles of the components of the appliance in the system of FIG. 3.

FIG. 9 is a block diagram of an alternate arrangement.

FIG. 10 is an electrical schematic diagram of the arrangement of FIG. 9.

FIG. 11 is an illustration of a control panel of the arrangement of FIG. 9.

FIG. 12 is a front view of the microwave oven according to another arrangement.

FIG. 13 is a side view of the microwave oven door of FIG. 12.

FIG. 14 is a top perspective view of a charging pad on the top portion of a microwave oven.

FIG. 15 is an illustration of a control panel of an alternate arrangement.

FIG. 16 is an electrical schematic diagram of the arrangement of FIG. 15.

FIG. 17 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 18 is an electrical schematic diagram of the arrangement of FIG. 17.

FIG. 19 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 20 is an electrical schematic diagram of the arrangement of FIG. 19.

FIG. 21 is a rear view of the microwave oven according to the arrangements of FIGS. 12-19.

FIG. 22 is a similar view as that of FIG. 21 except that the AC cord is shown.

FIG. 23 is a schematic logic flow diagram of an exemplary arrangement.

FIG. 24 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 25 is a front view of the microwave oven according to another arrangement.

FIG. 26 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 27 is an illustration of a control panel of an alternate arrangement.

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FIG. 28 is a schematic diagram corresponding to the arrangement of FIG. 14 showing the charging pad and a device being charged.

DETAILED DESCRIPTION

A multiple linked appliance system 1, for example, an appliance that comprises a combination microwave oven 2 and refrigerator 3 incorporating features described in the present application illustrated in the Figures. Although exemplary arrangements will be described with reference to the features shown in the drawings, it should be understood that other arrangements may have many alternate forms. In addition, any suitable size, shape or type of elements or materials could be used. The computer or controller devices described in this application may be constructed having one or several processors and one or several program product modules stored in one or several memory elements. For illustration, computer or controller components may be described as individual units by function. It should be understood, that in some instances, these functional components may be separated or combined in other components.

In the exemplary arrangements, the circuits described herein may comprise one or more circuits including processors which for purposes hereof corresponds to any electronic device that is configured via circuit executable instructions that can be implemented in either hardware circuits, software, firmware or applications that are operative to enable the circuits to process data and carry out the other actions described herein. For example, the circuits may include circuits that correspond to one or more or a combination of a CPU, FPGA, ASIC or any other integrated circuit or other type or circuit that is capable of processing data. The processors may be included in a computer, server or other type of electronic device. Further, the circuits described herein may include data stores that correspond to one or more of volatile or non-volatile memories such as random access memory, flash memory, magnetic memory, optical memory, solid state memory or other devices that are operative to store computer executable instructions and data. Computer executable instructions may include instructions in any of a plurality of programming languages and formats including, without limitation, routines, subroutines, programs, threads of execution, objects, methodologies and functions which carry out the actions such as those described herein. Structures for the circuits and processors may include, correspond to and utilize the principles described in the textbook entitled Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh S. Gaonker (Prentice Hall, 2002), which is incorporated herein by reference in its entirety. Of course it should be understood that these circuit structures are exemplary and in other embodiments, other circuit structures for storing, processing, resolving and outputting information may be used.

In exemplary arrangements the refrigerator may be connected to a power supply that provides a connection that enables the microwave oven to be connected to the same electrical supply. A single plug, therefore, may serve to connect both appliances and the current required for each appliance may be supplied by the same supply power cord and circuit. In exemplary embodiments power may be supplied by the 110V AC current outlet.

To make this combination attractive for use in dorm rooms, hotel rooms, recreational vehicles, tractor trailer cabs, and other similar locations, it may be necessary to assure that the peak current draws of both appliances are not demanded from the supply at the same time. Many house-

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hold circuits are protected from overload conditions by an automatic circuit breaker that is activated when current in the circuit exceeds the breaker rating. This is 15 amps in many circuits.

The duty cycle of an exemplary refrigerator used in these combined appliance systems includes a current spike that occurs during the first few seconds of operation. This is the start up current for the refrigerator compressor. The current draw is considerably reduced as the compressor attains its full operational speed. In typical refrigerator appliances the peak current may be in the range of 7 to 9 amps, while the steady state current may level off at 1.4 amps or less. A microwave oven demands a relatively steady 8 to 13 amps of cooking power during operation of the cooking element. It is apparent that an overload condition may occur when both appliances are placed in operation absent suitable control circuitry.

In an exemplary arrangement, a combination microwave and refrigerator appliance system is constructed having a single electrical plug input supply. The electrical supply in the exemplary arrangement is directly connected to the microwave oven. The microwave oven is adapted to provide power to the refrigerator through a power supply outlet, and to auxiliary receptacles adapted for connection to devices that operate at a low power operation draw. The microwave oven includes at least one control circuit including a processor based controller adapted to monitor operation of the refrigerator compressor and control the power to the microwave magnetron cooking element and other components. The current draws on the low power receptacles are separately monitored for control by the microwave controller. The microwave controller is adapted to balance the duty cycles of the connected appliances in operative connection therewith to avoid overload conditions. A control logic flow is implemented internally within the circuitry of the microwave controller. A receptacle or other power connecting power supply outlet for the refrigerator and the low power auxiliary receptacle may be implemented as part of the microwave control panel on the microwave oven.

In one arrangement, the auxiliary outlets are constructed to provide low power for the purpose of recharging batteries included in cellular mobile phones, personal media devices and digital cameras, in addition to operating lap top computers and other similar low power devices. The current to the auxiliary outlets is sensed by suitable circuitry in operative connection with the microwave controller.

In another exemplary arrangement, the power to the auxiliary outlets is disabled through operation of the microwave controller when the microwave magnetron is energized or whenever the current to the auxiliary outlets exceeds a preset value.

In one exemplary arrangement, a programmed control model for control logic flow is established and executed by the microwave controller. The model is dependent on the state of operation of the microwave cooking element or elements which are referred to herein as a magnetron. As part of the exemplary control model, the power draw of the compressor is monitored to sense operation of the compressor to compress refrigerant to provide cooling. When cooking power is demanded by the microwave the compressor is disabled by having electrical power thereto withdrawn by the at least one control circuit for a preset minimum period. When power demand to the magnetron ceases, refrigerator compressor power is restored provided that the preset minimum period has expired.

In another exemplary arrangement of the control model, sensing circuits are operative to monitor current draw on the

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auxiliary outlets. The control model is adapted to cause the controller to disable the power to the auxiliary receptacles, if the microwave magnetron is in operation. In addition the auxiliary receptacles are disabled if a predetermined maximum current draw is sensed. Another control model is based on operation of the refrigerator and operates to disable the auxiliary receptacles when the compressor is in the start up mode. Of course these approaches are exemplary and in other arrangements, other approaches may be used. Further while in the exemplary arrangement the at least one control circuit which is included in the controller is integrated with the microwave oven, in other arrangements the controller may be integrated with the refrigerator or other device, or may be configured as a separate component.

In one aspect of an exemplary arrangement, a non-transitory processor readable medium having processor executable program instructions embodied therein for operating at least one processor of a control circuit to control an appliance system of multiple linked components including a microwave oven, a refrigerator, and an auxiliary power supply outlet is provided. The processor executable program code causes the control circuit to disable the refrigerator and the auxiliary power supply outlet, when the microwave demands high power such as magnetron cooking power, and enable power delivery from the auxiliary power supply outlet when the microwave is not drawing cooking power.

One exemplary arrangement of a multi-component interconnected appliance system 1 is illustrated in FIG. 1. This arrangement consists of two components, a refrigerator 3 and a microwave oven 2. Refrigerator 3 is electrically connected to microwave oven 2 by power cord 7 to refrigerator receptacle 15, shown at the rear of the microwave 2 in FIG. 2. Refrigerator 3 is generally subject to control by the microwave microprocessor controller which is alternatively referred to herein as a power control circuit 4 of the microwave oven 2. The power control circuit may be operative to cause electrical power to be selectively delivered to and/or withheld from the microwave magnetron and the refrigerator compressor. A single power cord 8 provides input electrical power to the system 1 from receptacle 5 which provides a source of electrical power, through microwave 2. In the case where stand alone components are used, as shown in FIGS. 1 and 2, microwave oven 2 is connected directly to power source 5. The refrigerator 3, as the heaviest component, is used as the base with the microwave oven 2 stacked on top. In the selection of the refrigerator 3, it would be advantageous in some arrangements for the height of the refrigerator to be no more than 48 inches above the floor. This provides a more ergonomic operation of the microwave oven 2 for the user. In addition, in the stacked position of the components in an exemplary arrangement, the doors 9 and 10 of the microwave 2 and refrigerator 3, respectively, are arranged in a common plane.

At least one power control circuit 4 serves as a controller for the operation of the microwave oven 2 and is also adapted to control the other components of system 1, as shown in FIG. 3. Power is distributed throughout the system 1 under control of microwave controller 4 and digitally operated switches such as relays 19 and 20 represented in FIG. 3. It should be understood that in some arrangements the relays may control power delivery via mechanical contacts while in other embodiments, solid state relays may be used. Power is distributed to each of the appliance components 2 and 3, and to auxiliary low power receptacles 11 and 12. In use lamps 13 and 14 in the form of LEDs or the like may be positioned adjacent to the auxiliary receptacles to indicate power being available from the adjacent receptacle

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or power to the receptacle being disabled. The low power auxiliary receptacles 11 and 12 are provided to permit convenient access for plugging in a low power device, for example, devices including rechargeable batteries, such as cellular phones, PDAs, or other electronic devices that do not demand high power. As shown in the graph of FIG. 8, there are instances during which, if more than one of the appliances is in use, the cumulative current would cause an overload condition.

An exemplary control panel 22 of microwave oven 2 may be adapted to provide a display of the particular status of the controlling relays. For example, LEDs 13 and 14 may indicate that power to the outlets 11 and 12 are disabled or available. In one exemplary arrangement the lamps will light when power is available at the outlet and flash when disabled. In another exemplary arrangement the lamps will light when power is not available at the outlet and not activate when power is available at the outlet as a means to reduce the standby power draw. A button operated touch panel is used in the exemplary arrangement to provide manual control.

As shown in FIG. 4, in order to control the power to the microwave 2, refrigerator 3 and receptacles 11 and 12, sensing circuits, may be coupled to the at least one control circuit to monitor current draw by the appliance components and the auxiliary receptacles. A relay 20 is connected in the power line to the refrigerator and may be actuated by signals from controller 4. In particular, according to an exemplary arrangement, sensing circuits 16, as shown in FIG. 4, have sensors 17 and 18 coupled to the power line of the auxiliary outlets 11 and 12 to monitor the current being drawn by a connected device. Sensors 17 and 18 may include current sensing transformers of the type available from Triad Magnetics of Corona, Calif. The signals generated by sensors 17 and 18 may be used to activate switches or other control components, such as relays 19. Relays 19 may be actuated by the at least one control circuit 4 to enable and disable the delivery of power to the low power auxiliary outlets 11 and 12 in response to signals from sensors 17 and 18. A maximum current may be set through the program logic associated with the at least one power control circuit 4 to prevent overload of the outlets 11 and 12. In one arrangement of the system, the maximum current limit is set at 2 amps, and the control circuitry is operated to cease power delivery in situations where the power draw exceeds this amount. Of course this approach is exemplary.

In another exemplary arrangement, a clock function 21 included in the at least one power control circuit 4 is used to provide timed delays during which, for example, refrigerator 3 would be prevented from undesirably rapid on/off cycles. When the compressor of the refrigerator 3 is disabled during microwave cooking operation, a time delay of 3 minutes is provided during which the compressor of the refrigerator 3 will remain disabled, even if microwave use is only for a short period. Control circuit 4 may be programmed to manage the power delivery to the components of the appliance to avoid overload conditions, while minimizing disruptions in the use of an individual appliance component. A model of operative events and related control operations may be designed into the program instructions executed by at least one control circuit 4 to provide a control methodology as illustrated in FIGS. 5-7.

In one exemplary arrangement, as illustrated in the block diagram of FIG. 3, at least one control circuit 4, constructed as part of the controller for microwave 2, is adapted to receive and process the sensor signals and identify particular events in the system 1 related to a particular appliance

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component or combination of appliance component conditions. Circuit 4 controls the power to microwave 2 and refrigerator 3 and also low power receptacles 11 and 12 to avoid overload conditions. The circuit 4 is operative to execute the control methods illustrated and described below. In one exemplary arrangement, the circuit 4 is operative to control operations of microwave oven 2 and is adapted to execute the program instructions described below. The at least one control circuit is coupled directly to refrigerator outlet 15 and low power outlets 11 and 12.

In one exemplary arrangement, shown in FIG. 1, the outlets 11, and 12, are included as part of the front control panel of microwave oven 2. In FIG. 2, in another arrangement, the auxiliary receptacles 11 and 12 and refrigerator receptacle 15 are accessible at the rear of the microwave oven 2. In these alternative arrangements, the microwave oven 2 is connected by supply cord 8 directly to power supply receptacle 5. Refrigerator 3 is connected by power cord 7 to receptacle 15 on microwave oven 2 as shown in FIG. 2.

In one exemplary arrangement, control models for program logic flows are established as shown in FIGS. 5-7 for execution by the at least one control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware associated with the circuit 4. The models shown are, in the first instance, dependent on the state of operation of microwave oven 2. The current demands of the microwave 2 when drawing cooking power are generally the most significant contribution to overload, as shown in FIG. 8. To avoid overload conditions, power to the low power receptacles 11 and 12 and refrigerator receptacle 15 is disabled during microwave magnetron operation. If the refrigerator 3 compressor is drawing power when the microwave 2 is turned on to commence cooking, the power to the refrigerator compressor is turned off and clock function 21 is used to determine a predetermined period during which the compressor of refrigerator 3 cannot be restarted. A time delay, for example, of 3 minutes, may be set through programming of the at least one control circuit and when this delay period has expired, receptacle 15 may again be enabled, providing the control circuit determines in accordance with its programming and sensed parameters that microwave cooking operation has ceased. This prevents a too rapid restart of the compressor that may otherwise result in damage.

In some exemplary arrangements, the at least one control circuit of the power controller may operate responsive to sensing the power draw of the refrigerator and the cooking element of the microwave oven so as to detect the power draw reaching a threshold which should not be exceeded to prevent an overload condition. In other exemplary arrangements, the control circuitry may operate to detect inputs that may be provided by input devices and which are operative to cause power drawing components of devices such as the magnetron of the microwave oven or the compressor of the refrigerator to operate. In such arrangements, the control circuitry may operate to detect the signal from a thermostat within the refrigerator which indicates that the thermostat is signaling that the refrigerant compressor should operate to cause the temperature to be lowered within the cooling area of the refrigerator. In such arrangements, the at least one control circuit may operate to detect the signal from the thermostat and prevent the delivery of power to the compressor in situations where the cooking element of the microwave oven is operating. In such arrangements the control circuitry may delay the supply of power to the

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compressor until the cooking element of the microwave oven has ceased operation. Likewise in an exemplary arrangement the at least one control circuit may be operative to detect inputs to at least one input device of the control panel of the microwave which are provided by a user to commence microwave operation. In response to the detection of such inputs, the exemplary control circuitry may be operative to first cause a determination to be made as to whether the refrigerator is drawing the level of power that indicates that the compressor thereof is operating. In response to a determination that the refrigerator is drawing a level of power that is incompatible with operation of the microwave cooking element, the exemplary control circuitry may be operative to cause power to the refrigerator compressor to be withdrawn. Thereafter the at least one control circuit may be operative to cause power to be supplied to the cooking element of the microwave. Further in exemplary arrangements, the at least one control circuit may also monitor the power draw of auxiliary outlets or other power delivery points to assure that the level of draw that is currently occurring will not be an impediment to an operation that is being requested by an input device of the apparatus before the apparatus begins to operate in a manner that will cause increased power draw. Thus the exemplary appliance apparatus enables the preventative action of discontinuing operation of a power drawing component before instituting operation of another component that draws a high level of power. Of course it should be understood that this approach is exemplary and in other arrangements, other approaches may be used.

In the arrangement shown in FIG. 5, if low power is demanded at receptacle 11 or 12 and microwave oven 2 is not in use for cooking, power is supplied to the low power receptacles, provided further, that the current demand at an individual outlet does not exceed a preset limit, for example, 2 amps. Since the auxiliary outlets may be enabled during refrigerator compressor operation, there may be an overload generated at peak compressor operation. In one arrangement the at least one control circuit acts to disable the auxiliary outlets during compressor startup to prevent accidental overload of the system. Therefore as illustrated in the logic flow diagram of FIG. 5, control circuitry may be adapted to check the operational status of the refrigerator, as well as the microwave oven, prior to enabling the auxiliary outlets.

FIGS. 9-11 illustrate another exemplary arrangement. In this arrangement the sensing components 117 and 118 are configured to reduce the risk of overload by the combined demands of the auxiliary outlets 111 and 112 and the refrigerator outlet 115. In the exemplary configuration as shown in FIG. 10, current sensor 117 is configured to monitor the current draw through the refrigerator outlet 115 and the circuitry is operative to limit the refrigerator current draw at the outlet 115 so that it does not exceed 10 amps. Current sensor 118 is connected to monitor the combined current in the auxiliary outlets 111 and 112. Current sensor 118 and the control circuitry is configured to limit the combined auxiliary outlet current draw to 4 amps. In this manner the risk of overload is minimized. As represented in the block diagram of FIG. 9, the microwave 102 has at least one control circuit comprising controller 104 that is operatively connected to power supply 105. Clock function 121 which is shown schematically separately but may be part of the controller provides a timing device to determine a restart delay for power to refrigerator 103. Sensing circuit/sensor 117 is configured to monitor the current demanded by refrigerator 103 and sensing circuit/sensor 118 is connected to low power receptacles 111 and 112 is operative to monitor

the combined current draw on receptacles **111** and **112**. In the exemplary arrangement the control circuitry is shown as operative to control the availability of electrical power to some devices as a whole. For example, if the at least one control circuit operates to cause power not to be available to the refrigerator, all components of the refrigerator, such as the internal lights, air circulation fan, etc., are not supplied with electrical power, in addition to the compressor, which is the component which is most likely to draw power at a level which may be excessive. However in other arrangements, the at least one control circuit may be configured to deliver and withhold power selectively to individual refrigerator components or groups of such components. Thus in such arrangements the power control circuitry may be operative to withdraw power to the high power draw component(s) such as the compressor, while still making power available to other low power draw components such as the internal fan and/or lights.

Likewise in exemplary arrangements, the power control circuitry is operative to selectively allow power to be available or withdrawn from components of the microwave oven. For example, exemplary arrangements control the availability of power to selected components of the microwave oven such as the magnetron and the auxiliary outlets. The at least one power control circuit of exemplary arrangements may operate to maintain electrical operation of certain components, even though electrical power to other components is not available. For example, an exemplary controller may operate to maintain power to the clock display output on the control panel at all times. Further some exemplary arrangements may assure that power is maintained to control circuitry with programmed settings so that programmed data is not lost. This may include for example programmed data concerning a future time to turn on the cooking function, the power level and/or how long to cook. This way if the memory of the microwave has been programmed to begin to cook a food item placed inside the microwave oven at a future time so it is cooked by the time a person returns (for example) the programmed instructions to carry out those instructions will not be lost. Alternatively, configuration data that enables the microwave oven controller to communicate in a wireless network or with other devices will be preserved even though the control circuitry operates to cause electrical power not to be available to certain components. Of course these are merely examples.

It should be understood that for purposes hereof when it is stated that power is withdrawn or not made available to a microwave oven, refrigerator or other assembly of components, the terminology refers to not making such power available to the entire assembly or to only certain selected components that draw high power such as the refrigerant compressor or magnetron. Likewise herein references to the microwave or the refrigerator operating or running refers to operation of the respective high power draw components such as the magnetron or the compressor, for example.

In an exemplary arrangement, as shown in FIG. **11**, a control panel **122** is arranged with at least one input device in the form of a keypad **123** for manual control and a display **124**. Auxiliary outlet **111** is shown as accessible from the front and is associated with a status LED indicator and reset button **113** that may be caused to be operative during use and switch to a flashing mode when the microwave is drawing cooking power. Refrigerator outlet **115** is also accessible on the exemplary front panel and is associated with an LED indicator and reset button **114**. Similarly LED indicator **114** is controlled to be on by being illuminated during use of the refrigerator and to switch to a flashing mode when the

microwave is drawing cooking power. In another exemplary arrangement, the status LED indicator and reset button **113** may be caused to be off during use and switched on or to a flashing mode when the microwave magnetron is drawing cooking power. Similarly, in this arrangement, the LED indicator **114** is controlled to be off during operation of the refrigerator compressor and switched on or to a flashing mode when the microwave radiation cooking element is operating.

A further exemplary arrangement of the logic flow operational model is shown in FIG. **6**. In this model, the refrigerator compressor draws or demands power. This may be triggered by a temperature rise of the refrigerator interior area within the housing of the refrigerator and involve start up of the refrigerator compressor with an associated peak power demand. If the microwave cooking element is sensed by the control circuitry as currently drawing cooking power, the programming of the control circuitry causes power not to be available the refrigerator so that operation of the refrigerator compressor will be delayed. If the microwave cooking element was on and subsequently cycled off, the clock function **21** must be checked by the controller to determine if power availability to the refrigerator to restart can occur. Under some circumstances, it may be necessary to give the refrigerator compressor priority to prevent an undesirable rise in temperature. In the latter instance, the at least one control circuit can be coupled to the refrigerator temperature sensor to execute a programmed sequence during which the microwave cooking element will be disabled by not having power supplied thereto to allow the refrigerator to operate long enough to return to proper operating temperatures.

In the exemplary arrangement of FIG. **7**, the exemplary control circuitry operates to give priority to the power demands of the microwave oven, as indicated above. Use of the receptacles **11**, **12**, and **15** are, therefore, caused to be disabled during microwave cooking operation. The operational models which carry out the logic represented in FIGS. **5-7**, may be established by logic flows implemented by instructions that are programmed or imbedded in the control circuitry of controller **4**.

In this manner an appliance system of linked components, including a microwave oven, refrigerator, and at least one low power draw device or appliance may all be connected through a common supply cord to a releasably connectable receptacle providing a source of house current or other electrical power level without the risk of inconvenient interruptions or damage during use caused by overloads.

It is also advantageous to provide such a combination microwave/refrigerator system that also provides auxiliary outlets for low power applications, such as for the purpose of recharging batteries in cellular phones, operating lap top computers and other low power devices, while controlling the operation of the appliance to avoid overload conditions.

In another exemplary arrangement as illustrated in FIGS. **12** and **13**, the auxiliary outlets or electrical power receptacles **211**, **212** may be included as part of the front control panel **222** of the microwave oven **202** and located on the upper portion **270** of the front control panel **222**. The auxiliary outlets **211**, **212**, front control panel **222** and microwave oven **202** are similar to auxiliary outlets **11**, **12**, front control panel **22**, and microwave oven **2** except as discussed below. In this exemplary arrangement, the auxiliary outlets **211**, **212** are positioned side by side with respect to each other with each of the auxiliary outlets **211**, **212** being at the same height as the other. The auxiliary outlet **211** of FIG. **12** may be associated with a status LED indicator and reset button **213**, which is located on the lower

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portion 272 of the front control panel and in vertical alignment with the auxiliary outlet 211. The status LED indicator and reset button 213 may be caused by the control circuitry of the controller to be on during use and switched to a flashing mode to indicate that power is not available therefrom when the microwave oven 202 is drawing cooking power. The auxiliary outlet 212 of FIG. 12 may be associated with status LED and reset button 214, which is located on the lower portion of the front control panel and in vertical alignment with the auxiliary outlet 212. The status LED indicator and reset button 214 may be caused by the controller to be on during use and switched to a flashing mode to indicate that power is not available therefrom when the microwave oven 202 is drawing cooking power thereto is withdrawn. In another exemplary arrangement, the status LED indicator and reset button 213 may be caused to be off during the time power is available for use and switched on or to a flashing mode when the microwave oven is running and power thereto is withdrawn. Similarly, in another arrangement, the status LED indicator and reset button 214 may be caused to be off during power availability and switched on or to a flashing mode when the microwave oven is running or the refrigerator is running and the controller causes power not to be available. Other elements and operational features may be similar in structure and function as that of the arrangements shown in FIGS. 1-11. Thus, the same reference numbers will be used in this exemplary arrangement to indicate elements that are similar in the arrangements shown in FIGS. 1-11.

Smart technology may be integrated in some of the exemplary arrangements. For example, a user may be able to monitor and/or control the refrigerator 3 such as by turning it on and off remotely by a remote device 217. The remote device 217 may include a hand held device such as a cellular phone. The cell phone may also be a smart phone. In some exemplary arrangements, the refrigerator, the microwave and/or the controller may include circuitry suitable for communication in a wireless network. Such a wireless network may be established in the facility, residence, office or other location where the combined refrigerator and microwave appliance is operated. Such devices may include circuitry that enables transmission of wireless signals to and from such components. Such communications may include communications of operational properties such as operating status, temperature, programmed values or other information that is pertinent to the operational condition of the particular device. In further exemplary arrangements, circuitry may be operative to enable received wireless messages to modify the operational condition and/or the programming of the particular device.

For example in some exemplary arrangements, the user may be able to communicate from a wireless phone via cellular or WiFi connection to determine that the refrigerator is operating, the temperature therein, the operational status of the compressor or other items. Alternatively and/or in addition, the user may be able to remotely control components of the refrigerator. These may include, for example, the ability to remotely turn on the internal light within the refrigerator and to view the food items currently housed within the refrigerator via one or more electronic cameras positioned therein. This may enable a user, for example, to determine that they need to purchase additional groceries or other items for purposes of an upcoming meal or other activities. Alternatively and/or in addition, in some exemplary arrangements, instructions may be utilized to change the temperature within the refrigerator. This may be done,

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for example, to chill certain grocery items that may need to be cooled or frozen for certain purposes. Of course these approaches are exemplary.

Likewise the microwave oven may include interface circuitry which enables the remote monitoring of the condition of the microwave oven components via a remote wireless device. This may include, for example, determining the periods of past operation and current status of the microwave oven such as whether it is currently being used to cook items. Alternatively and/or in addition, the remote monitoring capabilities may include determining the programmed status of the controller of the microwave oven such as the controller being programmed to cook an item housed in the microwave oven at a set future time or for a particular duration at a particular power level. Alternatively and/or in addition, the remote operational capabilities associated with the microwave control circuitry may include the ability to turn on an internal light within the cooking chamber of the microwave oven and to view via a camera whether an item is contained therein. Further such remote capabilities may also include the ability to remotely change the program parameters so as to initiate cooking at a different time or at a different power level. Likewise exemplary arrangements may include having the wireless interface in operative connection with the at least one power control circuit to provide the ability to monitor the current status of power draw on auxiliary outlets, the occurrence of alarm conditions, or the current status of other connected devices. It should be understood that such capabilities may be implemented in the controller circuitry or in separate circuitry of the microwave oven and/or the refrigerator. Further the exemplary arrangements may utilize communications interface capabilities included in circuitry of the controller to facilitate monitoring and operational control of the appliance. Of course these capabilities are exemplary and in other arrangements, other approaches may be used.

In an exemplary arrangement a charging pad 219 (FIG. 14) may be provided on the microwave oven 2 or other suitable location to receive a smart phone or other chargeable device for purposes of charging the device. For example, a wireless charging pad 219 may be positioned on top 225 of the microwave oven 2 for recharging the smart phone or other device. The charging pad 219 may be built into the top 225 of the microwave oven 2 or may be a separate component that is mounted to the top 225 of the microwave oven 2 or other location. The exemplary charging pad 219 includes an inductive charging pad and includes a recessed area 220 for receiving an item to be charged such as the smart phone. The at least one control circuit may include or be in operative connection with a wireless interface 221 configured for communicating with the remote control device 217 for controlling the microwave oven or refrigerator and work in conjunction with the control circuitry to perform functions such as removing the supply of electrical power to the microwave oven 2 and/or refrigerator 3. In an exemplary arrangement, USB ports 223, 224 may be provided in the area of the charging pad 219. Alternatively, or in addition, power outlets may be provided in proximity to the charging pad 219. Alternatively, the charging pad 219 may be provided on the front, side, rear or bottom of the microwave oven 2, or at another suitable location in connection with the combined appliance structure.

The exemplary charging pad 219 may utilize inductive or wireless charging, which uses an electromagnetic field to transfer energy between the charging pad 219 and the device being charged. In general, the charging pad 219 may include a primary inductive coil 402 (FIG. 28) in connection with

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circuitry that is operative to create an alternating electromagnetic field that is received by a secondary inductive coil **404** (FIG. **28**) connected to the circuitry of the device being charged such as device **217**. Power from the electromagnetic field is converted back into electric current to charge a battery **406** (FIG. **28**) in the device. FIG. **28** shows an exemplary arrangement in which the charging pad **219** utilizes inductive charging to charge the device **217**. In this arrangement, the charging pad **219** includes an inductive charging station **408** and the primary inductive coil **402**. The power source **5** provides electrical power to the inductive charging station **408** and the other components of the charging pad **219**.

The inductive charging station **408** is provided for inductively charging the device **217** and may be built into or otherwise attached to the charging pad **219**. The inductive charging station **408** may include the primary inductive coil **402** that is connected to the power source **5** for the microwave oven **2**. The recessed area **220** may define a cover of the charging pad **219** that covers the primary inductive coil **402** and provide a surface on which the remote device **217** may be placed for charging. The inductive charging station **408** may also include one or more capacitors coupled in series and/or parallel with the primary inductive coil **402** to form an LC circuit. The inductance value of the primary inductive coil **402** and the capacitance value of the capacitor or capacitors may be selected to achieve a desired resonant frequency which corresponds to a frequency of a coil and circuitry in the device being charged, but it should be noted that this exemplary arrangement is not limited to any particular inductance and/or capacitance values and/or any particular power source ratings.

The device **217** or other device to be charged may include the battery **406** that provides electrical power to the components and circuitry of the device. The battery **406** may comprise a rechargeable battery or batteries including lead acid, nickel cadmium (NiCad), nickel metal hydride (NiMH), lithium ion (Li-ion) or lithium ion polymer (Li-ion polymer) batteries. The device may include any number of batteries, the size and rating of which may vary. The battery **406** may also comprise power conduits, connectors, receptacles, battery connectors, or power cables coupled with batteries.

The device **217** or other device to be charged may include an inductive charger **410** for charging the battery **406** when the device **217** is placed on or in the vicinity of the inductive charging station **408** of the charging pad **219**. The inductive charger **410** may be built into or otherwise attached to the device to be charged. As schematically represented in FIG. **28**, the inductive charger **410** may include the secondary inductive coil **404** and a charging circuit **412** that is connected to the battery **406**. The inductance value of the secondary inductive coil **404** may be selected to correspond or complement the inductance value of the primary inductive coil **402**, but it should be noted that in exemplary arrangements the secondary inductive coil is not limited to any particular inductance value. Likewise, the power rating of the charging circuit **412** may be selected to match or complement the rating of the battery **406**. The two inductive coils **402**, **404** in proximity combine to operate in a manner similar to the principles employed in an electrical transformer. Further in some arrangements greater distances between primary and secondary inductive coils and/or more effective charging can be achieved when the inductive charging system uses resonant inductive coupling. Of course the described approaches are exemplary and in other arrangements other approaches may be used. In some exem-

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plary arrangements the charging pad may be in operative connection with the at least one control circuit that controls power availability to components of the device. For example, the control circuitry may operate in accordance with its programmed instructions to cause power to not be available to the charging pad when the microwave draws cooking power. Alternatively or in addition the control circuitry may be operative to cause power not to be available to the charging pad responsive to power draw by the refrigerator compressor, the auxiliary outlets or other items, and/or cumulative power draw of multiple items.

As shown in FIGS. **16**, **18**, and **20**, a safety sensor which is alternatively referred to herein as a safety circuit **226** such as a smoke or gas sensor may be provided in connection with the microwave oven **2**. The smoke sensor **226** operates in connection with exemplary at least one control circuit to turn off the microwave oven upon sensing smoke or polluted air indicative of a potentially dangerous condition such as excessive smoke generated from overcooked food. The exemplary safety sensor **226** may be powered on or otherwise operational when the microwave oven is in operation. The sensor circuitry may operate responsive to processor executable instructions to determine the optimal activation point. The exemplary smoke sensor may be battery-powered or powered by the house current that powers the combined appliance with an optional battery backup when the power from the house current is out. The smoke sensor may include an ionization smoke sensor that uses a radioisotope, typically Americium-241, to ionize air. The exemplary ionization smoke sensor circuitry operates to turn off power to the magnetron cooking element of the microwave oven upon sensing a difference due to smoke indicative of a potentially dangerous condition. The smoke sensor alternatively may include a radiation type smoke detector that may contain a source emitter of infrared, visible, or ultraviolet light (typically an incandescent light bulb or light-emitting diode), a lens, and a photoelectric or other type of radiation sensing receiver (typically a photodiode) and suitable control circuitry.

An exemplary sensor **226** may include an alcohol sensor that is coupled with a thermistor **228**. An exemplary alcohol sensor **226** may operate in a set temperature range, such as from 32 to 104 degrees Fahrenheit. When a set level of heating is sensed by the thermistor **228**, the thermistor **228** through suitable control circuitry causes the alcohol sensor **226** to turn on and become operational and check for properties of the gas within the interior area of the microwave.

If the exemplary alcohol sensor **226** is operational due to the sensing of the set level of heating and senses polluted air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor to the controller **104**. Upon receiving the shutdown signal, the controller **104** determines that the radiation cooking emitting element of the microwave oven **2** should be shut down and causes the magnetron of the microwave to shut down through the withdrawal of electrical power. If (after the alcohol sensor is caused to be turned on by the thermistor) the alcohol sensor **226** senses air that is not indicative of a dangerous condition such as the air produced by normal cooking of food in the microwave oven **2**, the alcohol sensor circuitry will not send a shutdown signal to the controller **104** and the controller allows the microwave cooking activity to continue.

Alternatively or in addition, a fault indicator **230** may be coupled to the control circuitry of the controller **104** or other circuitry to indicate that there is a dangerous condition upon detection by the alcohol sensor **226**. For example, the fault

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indicator **230** may be an audible indicator such as a buzzer that is activated in response to the alcohol sensor **226** sensing polluted air indicative of a dangerous condition. In another example, fault indicator **230** may include the display **124** displaying a fault message such as “E-1” in response to the alcohol sensor **226** detecting polluted air indicative of a dangerous condition. Alternatively the fault indicator may output one or more signals, such as wireless alarm signals that can be detected by a receiver of an alarm system or through a remove device such as a smart phone.

An exemplary arrangement may include a combination of fault indicators. For example, upon the alcohol sensor **226** sensing air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor **226** to the controller **104**. Upon receiving the shutdown signal, the controller **104** determines that the microwave oven **2** should be shut down and causes the radiation emitting cooking element of microwave oven **2** to be shut down. In addition in an exemplary arrangement, a buzzer is activated and the display **124** displays a fault message such as “E-1” in response to the alcohol sensor **226** sensing polluted air indicative of a dangerous condition.

The alcohol sensor **226** may be reset automatically responsive to the alcohol sensor **226** no longer detecting gas indicative of the dangerous condition. Alternatively or in addition, the alcohol sensor **226** may be reset upon sensing by a suitable switch, opening of the microwave door **9** of the microwave oven **2**. The display may display a “bar” or other suitable icon to indicate that the alcohol sensor **226** is turned on. Other types of suitable safety sensors may also be used instead of the alcohol sensor to detect a dangerous condition within the cooking area of the microwave.

In addition to one or more sensors which detect the gases generated from cooked food, the sensor **226** may include a temperature sensing capability such as, for example, using the thermistor **228** and related elements mentioned above.

Referring to FIG. **24**, in another exemplary arrangement, the safety sensor which is alternatively referred to as a safety circuit may comprise an infrared sensor **326**. The infrared sensor **326** may include two oppositely positioned infra-red disposed infrared sensor elements in the form of a sensor emitter **328** and sensor receiver **330** (schematically shown in FIG. **24**) provided on the microwave oven and located in the microwave’s cavity **332**. The exemplary infrared sensor **326** operates as follows. The sensor emitter **328** emits radiation and the sensor receiver **330** senses sensor radiation from the sensor emitter **328** while the microwave element operates during a cooking session. When smoke that is indicative of a dangerous condition passes in between the infrared sensor elements **328**, **330**, a determination is made by the safety circuit that a transmission amount of sensor radiation from the sensor emitter reaching the sensor receiver has fallen by at least a programmed threshold amount during the cooking session, due to smoke in the cooking interior area. Responsive to the determination, the cooking element of the microwave oven is caused by the safety circuit to be no longer supplied with electrical power. The exemplary safety circuit may use the smoke point of oil or similar food products as the basis for its threshold amount, so that normal smoke emitted during the cooking or heating of food or beverages will not cause the infrared sensor **326** to deactivate cooking operation. The exemplary infrared sensor **326** would not require interaction from the microwave user. The exemplary safety sensor may be operative to cause an initial transmissivity level of sensor radiation that reaches the sensor receiver from the sensor emitter early in the cooking session to be stored in a data store or other memory associated with

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the safety circuit. The determination of a level of smoke corresponding to a dangerous condition is made in this embodiment responsive to circuitry operating in accordance with programmed instructions to detect that the transmission amount of sensor radiation reaching the sensor receiver has dropped by the threshold amount from the initial transmissivity level during the cooking session.

Referring to FIG. **25**, in another exemplary arrangement, the safety sensor or safety circuit may comprise a light sensor **334**, which detects the increase smoke density within the microwave’s cooking area which is alternatively referred to as a cavity. The light sensor **334** may also include a sensor emitter and sensor receiver. The light sensor **334** may be provided in the microwave cavity **332** and may operate as follows. At the beginning of a cooking cycle, the light generated travels through the clean air to the light sensor **334**. As smoke increases in density, the amount of light that reaches the sensor receiver is reduced. The circuitry of light sensor **334** includes a programmed trip point or threshold that corresponds to the reduced amount of light sensed caused by the amount of smoke, that is indicative of a dangerous condition. When the trip point is reached, the safety circuit causes the electrical power to the radiation emitting cooking element to be withdrawn. A circuit determination would be made based on the amount of smoke that corresponds to the trip point and its corresponding light sensor reading.

Referring to FIG. **26**, in another exemplary arrangement, the safety sensor may include an optical motion sensor **336**. The optical motion sensor **336** may also include a sensor emitter and sensor receiver. The optical motion sensor **336** may be positioned in the microwave cavity **332** adjacent air exhaust vents **338**, **340** of the microwave, which comprises an air passage that connects an area where food is cooked in the microwave oven to the air outside the housing of the microwave oven. The optical motion sensor **336** detects motion which is sensed due to the presence of smoke blown by an exhaust fan **342** of the microwave oven **2** through the air passage. The exhaust fan **342** is operative to cause air to move in the air passage connected to the microwave cavity. In an exemplary arrangement, the sensor emitter and sensor receiver are positioned to be operative to sense the transmission of radiation between the emitter and the receiver in the air passage. The optical motion sensor **336** has a trip point or threshold that corresponds to the presence of smoke of a predetermined density that corresponds to a reduced level of transmission that is indicative of a dangerous condition. When the trip point is reached, the optical motion sensor in combination with the control circuitry causes the cooking element of the microwave oven to be turned off. It should be noted that the exemplary optical motion sensor is not be positioned within the microwave cavity and directed toward a turntable therein, since the turntable itself may result in false alarms in some configurations. Of course it should be understood that other types of smoke sensors may be positioned in air passages in other alternative arrangements.

Alternative arrangements may include other types of smoke sensors. For example, some arrangements may include sensors that are operative to detect smoke by determining the level of volatile organic compounds (VOCs) in the air in the microwave oven cooking area. In some exemplary arrangements such VOC sensors may be positioned to sense air in at least a portion of the microwave cooking area. In some cases such VOC sensors may be positioned in an air passage that extends between the microwave cooking area and the air in the atmosphere outside the

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microwave. Such an arrangement may have an advantage in that positioning the sensor in the air passage may minimize the amount of cooking splatter and other contamination from the food cooked in the microwave oven that reaches the sensor.

Some exemplary arrangements may include a VOC sensor that comprises a tin dioxide semiconductor gas sensor. In some arrangements the semiconductor is formed on an alumina substrate with a thick film heater of ruthenium oxide on the reverse side. Of course this configuration is exemplary and in other arrangements other configurations and VOC sensor types may be used.

In exemplary microwave oven arrangements VOC sensors may be operated in conjunction with at least one suitable control circuit to detect conditions which correspond to a dangerous smoke condition. Such a dangerous smoke condition is determined responsive to the level of VOCs, such as carbon dioxide and/or carbon monoxide in the air in the cooking area of the microwave oven. Such compounds may generally indicate the presence of combustion which is corresponds to a potentially dangerous condition. Responsive to detecting a threshold VOC concentration in the air of the cooking area, the control circuitry in operative connection with the sensor is operative to cause power to be withdrawn from the magnetron of the microwave oven so as to prematurely end a current cooking session before the set and time thereof. In exemplary arrangements, the sensitivity of the VOC sensors is sufficient to detect a developing potentially dangerous condition and cause power to be withdrawn from the microwave cooking element before a fire or other condition causes damage to the microwave oven. This enables the sensor circuitry to reset when the dangerous smoke condition is no longer detected and enable the microwave oven to operate in a subsequent cooking session.

In some exemplary arrangements multiple sensors in operative connection with detection circuitry is utilized to determine the activation point for an alarm condition based on detection of parameters such as humidity, temperature, temperature rate of change, and gas constituents generated during cooking phases. Combinations of absolute and relative values and rates of change thereof may be detected for purposes of evaluating possible alarm conditions. Other types of sensors that may be used in exemplary arrangements include flame sensors. Flame sensors are operative, detect and provide signals indicative of the presence of a flame or fire. Upon the flame sensor detecting the presence of a flame, the flame sensor causes at least one control circuit to discontinue electrical power to the microwave oven cooking element. In some arrangements the flame sensor may take the form of an optical flame sensor. The flame sensor may be of the type that utilizes ionization current flame detection. Alternatively, the flame sensor may be of the type that utilizes thermocouple flame detection.

Alternatively or in addition, the fault indicator **230** may be coupled to the controller **104** or other circuitry to indicate that there is a dangerous condition upon detection of a potentially dangerous condition by any of the infrared sensor **326**, light sensor **334**, optical motion sensor **336**, or flame or fire sensor in the arrangements described above. For example, the fault indicator **230** may be an audible indicator such as a buzzer that is activated in response to the safety sensor **226** sensing polluted air indicative of a dangerous condition. In another example, fault indicator **230** may include the display **124** displaying a fault message such as "E-1" in response to the safety sensor **226** detecting polluted air indicative of a dangerous condition.

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Exemplary arrangements may include a combination of fault indicators. For example, upon the trip point or threshold value being reached by any of the detection circuitry of the infrared sensor **326**, light sensor **334**, or optical motion sensor **336**, a shutdown signal is outputted by the sensor **226** to the controller circuitry **104**. Upon receiving the shutdown signal, the controller **104** determines that the microwave oven **2** should be shut down and causes electricity to be withdrawn from the cooking element. In addition, a buzzer is activated and the display **124** displays a fault message such as "E-1" in response to the sensor **226** sensing polluted air indicative of a dangerous condition. In other exemplary arrangements, the controller or other circuitry may be operative to output signals that can be communicated to a remote location, indicative of an alarm condition that is detected through one or more detection circuits of the microwave oven or other connected devices. This may include, for example, the circuitry dispatching messages to a remote device such as a smart phone of a user. The messages caused to be dispatched responsive to operation of the control circuitry may be indicative of an alarm condition that can be output on the display of the user's device to advise that a potentially dangerous condition exists. Alternatively and/or in addition, the control circuitry may be operative to communicate messages to a central controller or alarm panel located in the facility or institution in which the microwave is operated. For example the circuitry may be operative to provide wireless communication to an alarm panel or central monitoring station which receives the information that there is a potentially dangerous condition at the microwave device located in a particular location, dormitory room or other identified area of the building or facility. In still other exemplary arrangements, messages corresponding to alarm conditions that are cause to be sent by the control circuitry of exemplary arrangements may be dispatched to devices or alarm monitoring stations of a security force for an oversight authority within the area in which the microwave is operated. Of course it should be understood that these approaches are exemplary and in other arrangements, other approaches may be used.

Exemplary arrangements may also include the features described in U.S. patent application Ser. No. 15/239,378 filed Aug. 17, 2016 which is published as US Patent Publications 2017-0059233 the disclosure of which is incorporated herein by reference in its entirety. In some exemplary arrangements an appliance like that shown in the incorporated disclosure may include a safe which is suitable for holding valuables or a user's rechargeable devices such as a smart phone. In some exemplary arrangements the safe may include a smoke sensor, heat sensor, flame sensor or other type sensor that is operative to detect a fire or other dangerous condition within the interior area of the safe. Further in exemplary arrangements the at least one control circuit or other circuitry may be operative to dispatch messages to a user's smart phone or other remote computer device to indicate such a fire or other dangerous condition within the interior area of the safe. In addition in exemplary arrangements the at least one control circuit or safe circuitry as described in the incorporated disclosure, may operate an audible alarm to give at least one audible signal of the dangerous condition. Also in exemplary arrangements messages may be dispatched to alarm monitoring stations associated with the building or institution in which the appliance is located. Further in exemplary arrangements a remote notification to a user's mobile device or other computer and/or to an alarm monitoring station may also be given in circumstances in which at least one tamper sensor of one of

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the types of the incorporated disclosure is operative to sense a safe tamper condition. In such circumstances the at least one safe circuit or other circuitry may be operative to cause a remote notification of the tamper condition to be given and/or an audible signal to be output from an audible alarm. Further in exemplary arrangements one or more cameras may be in operative connection with the control circuitry to provide to the user's mobile device or other remote computer and/or to an alarm monitoring station, images associated with the detected condition. These may include images captured by cameras with a field of view outside the safe or the microwave oven or refrigerator of the combined appliance. Alternatively or additionally in other arrangements cameras may be positioned to capture images of an interior area of the safe. In some arrangements this may include a camera that is operative to have a field of view directed at or through the safe opening so that in the event that the safe is opened by an unauthorized person, images of the individual who is responsible for breaking into the safe may be captured. Further in exemplary arrangements the signals may be provided by the safe circuitry which can operate on a battery if the safe is disconnected from the combined appliance and no longer receives power from the at least one power control circuit thereof. Further the safe circuit may also provide GPS or other position signals so that the location of the safe can be tracked. Of course it should be understood that these approaches are exemplary and other arrangements other approaches may be used.

The exemplary detection circuitry of the smoke sensor, infrared sensor 326, light sensor 334, or optical motion sensor 336, may be reset automatically upon the sensor not detecting gas or other conditions that are no longer indicative of the dangerous condition. Alternatively or in addition, the sensor may be reset upon circuitry sensing opening of the microwave door 9 of the microwave oven 2. The display may display a "bar" or other suitable icon to indicate that the sensor is turned on. Other types of suitable safety sensors and circuitry may also be used to detect dangerous conditions. Further in other exemplary arrangements, other circuitry may be in operative connection with the combined appliance or separate components so as to address dangerous conditions. Such items may include, for example, a suitable fire extinguishing system that may be automatically triggered in response to detecting conditions corresponding to fire or smoke within the cooking chamber of the microwave oven. For example in some exemplary arrangements, a compressed supply of carbon dioxide may be included with or be positioned adjacent to the combined appliance. A suitable gas conduit and control valve may be positioned to deliver the carbon dioxide into the cooking chamber of the microwave oven responsive to the detection of flame, excessive temperature or smoke within the microwave cooking chamber. Suitable circuitry in operative connection with the controller or circuitry of the temperature, smoke or flame detection devices may operate to cause the control valve for the delivery of the carbon dioxide or other fire extinguishing material to be opened to cause the delivery thereof responsive at least in part to the detection of one or more of the alarm conditions. Further as can be appreciated, in some exemplary arrangements, the control circuitry may operate in accordance with its programmed instructions to require that the alarm condition be detected as existing for a programmed period of time before the control circuitry operates to cause the fire extinguishing material to be delivered into the cooking chamber. Further although exemplary arrangements may include carbon dioxide as the fire extinguishing material, in other embodiments other types of

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fire extinguishing or fire suppressing materials may be utilized. These may include, for example, chemical fire extinguishing or retarding materials in the form of powders or foams. Alternatively, and/or in addition, fire suppressing materials may include the delivery of nonflammable gaseous material. Of course these approaches are exemplary and in other embodiments, other approaches may be used.

As shown in FIGS. 15, 16 and 27, the exemplary front control panel 22 of the microwave oven 2 may include Universal Serial Bus (USB) ports 232, 234 for connection, communication, and power supply between the front control panel 22 and electronic devices such as a personal computer, cell phone, Smart Phone, Ipad®, Ipad®, or other suitable device to allow communication and/or charging of the electronic device plugged into the USB ports. In one exemplary arrangement, a first USB port 232 may be provided on the upper portion 236 of the front control panel 22, and a second USB port 234 may be provided on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112 and between the reset buttons 113, 114 as seen in FIG. 15. The first USB port 232 may be operatively connected to a three ampere fuse and a linear time-variant system (LVT) of 100 mA, 120 volts, and 12 watts. The second USB port 234 may be operatively connected to a linear time-variant system (LVT) of 200 mA, 120 volts, and 24 watts. The second USB port 234 may also be reset. The current sensor 118 may be constructed to limit the second USB port and the two auxiliary outlets to 12 amps. The USB ports 232, 234 may be in operative connection with respective printed circuit boards. Alternatively, as represented in FIG. 27, instead of auxiliary outlet 111, another USB port 237 may be provided on the front panel 22 at the location of the auxiliary outlet 111. Alternatively or in addition, one or more USB ports may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively or in addition, one or more auxiliary outlets may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively, the refrigerator outlet may be provided on the top, bottom, or one of the sides of the microwave oven.

FIGS. 17 and 18 show another exemplary arrangement of a control panel and control circuitry that includes USB ports 232, 234. In this arrangement, the first and second USB ports 232, 234 are located side by side on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112. The USB ports 232, 234 are also located rightwardly (as viewed in FIG. 17) adjacent a status LED indicator and reset button 240. In this exemplary arrangement, current sensor 218 is configured to monitor the combined current in the USB ports 232, 234 and the auxiliary outlets 111 and 112. The current sensor 218 is constructed to limit the combined current in the USB ports and auxiliary outlets 111 and 112, to 12 amperes. The LED indicator and reset button 240 may be controlled to illuminate when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and flash when disabled. In another arrangement, the LED indicator and reset button 240 may be controlled to be off when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and light on illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables power delivery from the auxiliary outlets 111, 112 and the USB ports 232, 234 so that power may be again supplied from them after a power interruption due to excessive power draw, when the combined current draw falls from above to below the limit. Of course it should also be understood that in exemplary

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arrangements, the controller or other control circuitry that operates to avoid excessive power draw may also operate to discontinue delivery of power from the receptacles and the USB ports in circumstances where the power draw of the microwave cooking element and/or the refrigerator compressor requires the power delivery from the auxiliary outlets and USB ports be discontinued. In such exemplary arrangements, the control circuitry may operate to automatically resume the delivery of power to such receptacles and ports or in other embodiments a manual input may be required to cause the delivery of power to be reinstituted. Of course it should be understood that these approaches are exemplary and in other arrangements other approaches may be used.

FIGS. 19 and 20 show an alternative arrangement in which one USB port 234 is located above the auxiliary outlets 111, 112 and rightwardly adjacent the status LED indicator and reset button 240. In this exemplary arrangement, the current sensor 218 is configured to monitor the combined current draw from the USB port 234 and auxiliary outlets 111 and 112. The current sensor 218 is configured to limit the combined current draw from the USB port 234 and auxiliary outlets 111 and 112, to 12 amperes. Alternatively, the current sensor 218 may be configured to limit the combined current in the USB port 234 and the auxiliary outlets 111 and 112 to 13 amperes. The LED indicator and reset button 240 may be controlled to illuminate when power to the auxiliary outlets 111, 112 and the USB port 234 is available, and flash when the control circuitry causes the outlets and ports to be disabled. In another exemplary arrangement, the LED indicator and reset button 240 may be off when power to the auxiliary outlets 111, 112 and the USB port 234 is available, and illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables operation of the auxiliary outlets 111, 112 and the USB port 234 so that power may be again supplied from them after the controller discontinues the supply of power thereto when the combined current draw falls from above to below the limit. Of course as is the case with the previously described arrangement, the controller and other circuitry may be operative to also discontinue the supply of electrical power to the auxiliary receptacles and/or USB ports when power draw is required for the magnetron of the microwave or the refrigerator compressor is sensed that power delivery to other devices needs to be discontinued to limit excessive power draw. In such circumstances, the discontinuance of power to the auxiliary receptacles and USB ports may be automatically reinstated responsive to operation of the controller. Alternatively, in other arrangements, manual inputs may be required from a user to reinstitute the electrical delivery therefrom. Further in some exemplary arrangements, the controller may be configured so as to require manual inputs to reinstate electrical delivery only under circumstances where excessive power draw above the limits from the one or more auxiliary outlets or USB ports has occurred, thus requiring a manual input to reinstitute the electrical power delivery therefrom. Of course these approaches are exemplary and in other arrangements other approaches may be used. Other elements of the arrangements of FIGS. 17-20 may be similar in structure and function as the arrangements shown in FIGS. 1-11. Thus, the same reference numbers are used in describing these exemplary arrangements to indicate elements that are similar to elements or components in the arrangements shown in FIGS. 1-11.

FIG. 21 shows the rear portion 244 of the exemplary microwave oven of the arrangements shown in FIGS. 12-20.

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Refrigerator outlet 15 is shown on and accessible from the rear portion 244 of the microwave oven and is associated with the LED indicator and reset button 214, which is also provided on the rear portion 244 of the microwave oven. FIG. 22 is a similar view as FIG. 21 except that an AC electrical cord 8 for the microwave oven is shown.

In the arrangements shown in FIGS. 12-22, control models for control logic may be established for execution of executable instructions by the controller or microprocessor which is also referred to herein as at least one electrical power control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware within the control circuit 104. The exemplary models and logic flow are, in the first instance, dependent on the state of operation of the microwave oven 2. The current demands of the microwave oven 2 are generally the most significant contribution to overload. To avoid overload conditions, in exemplary arrangements power to the low power receptacles or auxiliary outlets, refrigerator receptacle, and/or USB ports is disabled during microwave operation.

FIG. 23 shows a flow chart illustrating several control models for operational scenarios. The at least one power control circuit 104 begins by determining whether the microwave oven is turned on or operating (e.g. cooking) in step 246. When the microwave oven is turned on and operating to perform cooking, the rear refrigerator outlet 15, the two auxiliary outlets 111, 112 on the front control panel 22, and the two USB ports 232, 234 on the front control panel are all turned off or disabled, so that the total draw of current for the combination microwave and refrigerator is not over 15 amperes as indicated in step 248.

When the microwave oven is not drawing cooking power and items are plugged into the two USB ports 232, 234, two auxiliary outlets 111, 112, and rear refrigerator outlet 15, then the exemplary at least one control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 2 amperes (approximately the average amperes when the refrigerator compressor is running) in step 250. If the refrigerator outlet 15 is drawing less than 2 amperes, then all the outlets 15, 111, 112 and USB ports 232, 234 are caused to be enabled, so that power may be supplied through them as indicated in step 252. If the refrigerator outlet 15 not drawing less than 2 amperes, the at least one control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 254. If the refrigerator outlet 15 is drawing less than 14 amperes but not less than or greater than or equal to 2 amperes, then the auxiliary outlets 111, 112 and USB ports 232, 234 are disabled or turned off so that no power may be supplied from them as indicated in step 256. The refrigerator outlet 15 remains enabled. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 is disabled in step 258. This may be accomplished by tripping the relay 20 of the reset circuit off. In addition, the red LED light on the LED indicator and reset button 214 is turned on to identify the disabled condition of the refrigerator. Then, in step 260, the auxiliary outlets 111, 112 and USB ports 232, 234 are enabled so that power may be supplied through them.

Then, the exemplary at least one control circuit determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 262. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 remains disabled and the red LED light on the LED indicator and reset button 214 remains turned on to identify the disabled

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condition of the refrigerator 3. This condition may occur, for example, if an electrical heater is plugged into what is normally used as the refrigerator electrical supply outlet 15. When the refrigerator outlet 15 draws less than 14 amperes resulting from the overload condition being eliminated, the refrigerator outlet 15 will be enabled by the control circuit so that power may be supplied to the refrigerator outlet 15 upon the LED indicator and reset button 214 being depressed as indicated in step 264. Depression of the LED indicator and reset button 214 in this condition will also turn off the red LED light. The process then ends. It should be noted that the at least one control circuit 104 can make the determination in steps at the same time or in a different order.

It should be understood that in exemplary arrangements, determination as to the power draw from receptacles that have been disabled, may be determined through a process of again supplying power output through the receptacle. The power draw from the receptacle is monitored continuously after the power is restored and if it is detected that the power draw exceeds a threshold or other determined amount, power is discontinued to the receptacle. In some exemplary arrangements, the power sensing circuitry may operate in conjunction with the controller to calculate the current power draw level. The control circuitry may also operate in accordance with its programming to determine that other connected devices are consuming power which may necessitate not providing power to the receptacle so as to avoid an overload condition. Alternatively or in addition, the control circuitry may be operative to monitor other conditions that may be indicative of a problem when the power is restored to a receptacle, port or other control outlet. For example, responsive to a manual input to reinstitute the supply of power thereto, the control circuitry may operate to recognize conditions that correspond to an electrical short or other malfunction which necessitates an immediate withdrawal of electrical power thereto. This may include, for example, monitoring the rate at which power is drawn and the current flow increases to detect a short or other fault condition. Numerous different types of detection circuitry and control approaches may be implemented in order to help assure that if power output has been discontinued, that excessive power draw or undesirable conditions are not a problem when power is reinstated.

Although exemplary arrangements are described herein as used in conjunction with vapor compression refrigerators, embodiments employing the principles described herein may also be used with other types of refrigerators. Such refrigerators may include refrigerators that use thermoelectric cooling, such as Peltier elements to provide cooling. Other arrangements may include absorption refrigerators to provide cooling. In such arrangements the components of the refrigerator apparatus which draw electrical power, are controlled through operation of at least one power control circuit, to prevent, suspend or defer the operation thereof at times when the microwave radiation emitting cooking element of other components that draw electrical power are to be operated, so as to avoid exceeding a maximum threshold for current draw for the combined appliance that is permitted by the at least one control circuit.

It should be understood that the above description is only illustrative of the exemplary arrangements. Various alternatives and modifications can be devised by those skilled in the art without departing from the teachings of exemplary arrangements. Accordingly, the present application is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

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Thus the exemplary systems, arrangements, and methods of operation that have been described herein achieve desirable capabilities, eliminate difficulties encountered in the use of prior devices and systems and attain the useful results described herein.

In the foregoing description, certain terms have been used in describing exemplary arrangements for purposes of brevity, clarity and understanding. However, no unnecessary limitations are to be implied therefrom because such terms are used for descriptive purposes and are intended to be broadly construed. Moreover, the descriptions and illustrations herein are by way of examples and the inventive features are not limited to the particular features shown and described.

Further it should be understood that elements, features, relationships, devices and other aspects described in connection with one exemplary arrangement may be utilized in connection with other exemplary arrangements such that numerous different arrangements, functions and capabilities may be carried out. Numerous different aspects of described arrangements may be used together or in different combinations to achieve useful results.

Having described the features, discoveries and principles of the exemplary arrangements, the manner in which they are constructed and operated, and the advantages and useful results attained, the new and useful structures, devices, elements, arrangements, parts, combinations, systems, equipment, operations, methods, processes and relationships are set forth in the appended claims.

The invention claimed is:

1. Apparatus comprising:

an appliance including

a microwave oven,

a refrigerator,

at least one power control circuit, wherein the at least one power control circuit is in operative electrical connection with the microwave oven and the refrigerator,

a single power cord, wherein the single power cord is configured to be releasably connected to a source of electrical power, wherein the at least one power control circuit is supplied with electrical power only through the single power cord,

wherein the at least one power control circuit is operative to cause

electrical power to be withheld from at least one component of the refrigerator when a magnetron of the microwave oven draws cooking power, and electrical power to be delivered to the refrigerator when the magnetron does not draw cooking power,

wherein the microwave oven includes a smoke sensor, wherein the smoke sensor

is positioned in operative connection with a cooking area inside the microwave oven,

is in operative connection with the at least one power control circuit,

wherein responsive to at least in part to a level of smoke sensed by the smoke sensor, the at least one power control circuit is operative to cause cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time of the current cooking session,

wherein after the current cooking session has been caused to end prior to the set end time based on the sensed level of smoke, the at least one power control circuit is operative thereafter to enable the magnetron to receive cooking power in a next subsequent cooking session.

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2. The apparatus according to claim 1, and further comprising:

a safe, wherein the safe is in operative connection with at least one of the refrigerator and the microwave oven.

3. The apparatus according to claim 2

wherein the at least one power control circuit is in operative electrical connection with the safe, wherein the at least one power control circuit is operative to cause electrical power to be withheld from the safe when the magnetron draws cooking power.

4. The apparatus according to claim 3

wherein the safe includes

a safe body, wherein the safe body bounds a safe interior area, wherein the safe interior area is externally accessible through a safe opening,

a safe door, wherein the safe door is movably mounted in operative supported connection with the safe body, wherein the safe door is movable between a closed position in which the safe door closes the safe opening and an open position in which the safe door is at least partially disposed away from the safe opening,

a lock, wherein the lock is changeable responsive to at least one electrical signal, between a locked condition and an unlocked condition, wherein in the closed position of the safe door the lock in the locked condition is operative to prevent the safe door from being moved to the open position,

wherein the microwave oven includes at least one user input device configured to receive manual inputs from users,

wherein the microwave oven is operable to provide cooking power usable by the magnetron to cook items in the cooking area responsive at least in part to inputs through the at least one user input device,

wherein the at least one user input device is in operative connection with the lock,

wherein the lock is enabled to be changed from the locked condition to the unlocked condition responsive at least in part to at least one input to the at least one user input device.

5. The apparatus according to claim 4

wherein the safe further includes

at least one safe circuit, wherein the at least one safe circuit is in operative electrical connection with the at least one power control circuit,

a battery, wherein the battery is in operative connection with the at least one safe circuit,

an audible alarm, wherein the audible alarm is in operative connection with the at least one safe circuit,

at least one tamper sensor, wherein the at least one tamper sensor is operative to sense at least one safe tamper condition,

wherein the at least one safe circuit is operative responsive at least in part to a sensed safe tamper condition sensed by the at least one tamper sensor to cause the audible alarm to output an audible signal.

6. The apparatus according to claim 5

wherein the at least one tamper sensor includes at least one of

at least one conductive material mesh that extends adjacent to at least a portion of the safe interior area, wherein the at least one safe circuit is operative to detect a change in integrity of the material mesh which corresponds to the sensed safe tamper condition, or

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at least one conductive trace that extends in at least one of the safe walls or in the safe door, wherein the at least one safe circuit is operative to detect a break in electrical continuity of the at least one conductive trace which corresponds to the sensed safe tamper condition.

7. The apparatus according to claim 6

wherein the at least one tamper sensor includes at least one position sensor, wherein the at least one position sensor is operative to sense relative displacement of at least one of

the safe body relative to at least one of the refrigerator and the microwave oven, or

the safe door relative to the safe body.

8. The apparatus according to claim 7

wherein the at least one safe circuit is configured to cause the alarm to provide the audible signal responsive to the at least one tamper sensor sensing the sensed safe tamper condition using power from the battery when the at least one power control circuit does not supply electrical power to the at least one safe circuit.

9. The apparatus according to claim 8 and further including

at least one bracket, wherein the at least one bracket is in fixed operative mechanical connection with at least two of the microwave oven, the safe and the refrigerator.

10. The apparatus according to claim 9

wherein the safe is in fixed operative mechanical engagement with at least one of the refrigerator, the microwave oven and the at least one bracket through at least one releasable fastener, wherein the at least one releasable fastener is accessible to be released only from within the safe interior area.

11. The apparatus according to claim 9 and further including

a power connector that is usable to charge a battery of a mobile device,

wherein the power connector is in operative connection with the at least one power control circuit, wherein the power connector is positioned to be connected to the mobile device in the safe interior area.

12. The apparatus according to claim 1

wherein the microwave oven includes a USB port, wherein the USB port is in operative connection with the at least one power control circuit,

wherein the USB port is not operative to deliver electrical power from the USB port when the magnetron draws cooking power.

13. The apparatus according to claim 1

wherein the microwave oven further includes at least one output device including at least one of

a USB port,

an inductance charging pad,

an auxiliary electrical outlet,

wherein the at least one output device is in operative connection with the at least one power control circuit, and wherein the at least one power control circuit is operative to cause the at least one output device to be inoperative when the magnetron draws cooking power.

14. The apparatus according to claim 1

wherein the microwave oven includes a USB port, wherein the USB port is in operative connection with the at least one power control circuit,

wherein the USB port is operative to deliver electrical power.

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15. Apparatus comprising:
 an appliance including
 at least one electrical power control circuit,
 a microwave oven, wherein the microwave oven is in
 operative electrical connection with the at least one
 electrical power control circuit,
 wherein the microwave oven includes an interior cook-
 ing area,
 a smoke sensor, wherein the smoke sensor is positioned
 in operative connection with the cooking area,
 wherein the smoke sensor is in operative connection
 with the at least one electrical power control circuit,
 and wherein the at least one electrical power control
 circuit is configured to cause cooking power to be
 withdrawn from a magnetron of the microwave oven
 prior to a set end time of a current cooking session
 responsive at least in part to the smoke sensor
 sensing an amount of smoke,
 wherein the at least one electrical power control circuit
 is configured such that after ending the current
 cooking session prior to the set end time due to
 sensing the amount of smoke, to enable cooking
 power to again be available to the magnetron in a
 next subsequent cooking session,
 a refrigerator, wherein the refrigerator is configured to be
 in operative electrical connection with the at least one
 electrical power control circuit,
 wherein the refrigerator includes a plurality of electrically
 powered refrigerator components,
 wherein the at least one electrical power control circuit is
 operative to cause
 electrical power to be unavailable to at least one
 electrically powered refrigerator component when
 the magnetron draws cooking power, and
 electrical power to be available to the at least one
 electrically powered refrigerator component when
 the magnetron does not draw cooking power.

16. The apparatus according to claim 15 and further
 comprising:
 a safe, wherein the safe is in fixed operative mechanical
 connection with at least one of the refrigerator and the
 microwave oven.

17. The apparatus according to claim 16
 wherein the safe includes at least one of
 a lock, wherein the lock is electrically changeable
 between a locked condition and an unlocked condi-
 tion, and wherein the lock is in operative electrical
 connection with the at least one electrical power
 control circuit,
 a power connector configured to charge a battery of a
 mobile device, wherein the power connector is in
 operative electrical connection with the at least one
 electrical power control circuit.

18. The apparatus according to claim 17
 wherein the safe includes the lock, wherein in the locked
 condition the lock is operative to hold a safe door of the
 safe in a closed position,
 wherein the microwave oven includes at least one user
 input device configured to receive manual inputs from
 users,
 wherein the at least one user input device is in operative
 connection with the lock,
 wherein the lock is enabled to be changed from the locked
 condition to the unlocked condition responsive at least
 in part to at least one input to the at least one user input
 device.

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19. The apparatus according to claim 15
 wherein the microwave oven includes a USB port,
 wherein the USB port is in operative connection with
 the at least one electrical power control circuit,
 wherein the USB port is not operative to deliver electrical
 power from the USB port when the magnetron draws
 cooking power.

20. The apparatus according to claim 15, wherein the
 microwave oven further includes at least one output device
 including at least one of

a USB port,
 an inductance charging pad, and
 an auxiliary electrical outlet,

wherein the at least one output device is in operative
 connection with the at least one electrical power control
 circuit, and wherein the at least one electrical power control
 circuit is operative to cause the at least one output device to
 be inoperative when the magnetron draws cooking power.

21. The apparatus according to claim 15 and further
 including

a wireless interface, wherein the wireless interface is in
 operative connection with the at least one electrical
 power control circuit,
 wherein the wireless interface is operative to transmit
 signals indicative of a condition of at least one of the
 microwave oven and the refrigerator, to a wireless
 mobile device.

22. The apparatus according to claim 15, wherein the
 smoke sensor includes at least one of

a radiation emitter and radiation receiver,
 a photosensor,
 a motion sensor,
 an ionization sensor, and
 a VOC sensor.

23. The apparatus according to claim 15
 wherein the microwave oven includes a USB port,
 wherein the USB port is in operative connection with the
 at least one electrical power control circuit,
 wherein one USB port is operative to deliver electrical
 power.

24. Apparatus comprising:

a microwave oven, including a magnetron and an exter-
 nally accessible electrical connector, wherein the elec-
 trical connector is connectable to a plug,

at least one power control circuit, wherein the at least one
 power control circuit is in operative electrical connec-
 tion with the microwave oven and the electrical con-
 nector,

a single power cord, wherein the single power cord is
 configured to be releasably connected to a source of
 electrical power, wherein the at least one power control
 circuit is supplied with electrical power only through
 the single power cord,

wherein the at least one power control circuit is operative
 to cause

electrical power to be withheld from the electrical
 connector when the magnetron of the microwave
 oven draws cooking power, and

electrical power to be delivered to the electrical con-
 nector when the magnetron does not draw cooking
 power,

wherein the microwave oven includes a smoke sensor,
 wherein the smoke sensor

is positioned in operative connection with a cooking
 area inside the microwave oven,

is in operative connection with the at least one power
 control circuit,

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wherein responsive at least in part to a level of smoke sensed by the smoke sensor, the at least one power control circuit is operative to cause cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time of the current cooking session, 5

wherein after the current cooking session has been caused to end prior to the set end time based on the sensed level of smoke, the at least one control circuit is operative thereafter to enable the magnetron to receive cooking power in a next subsequent cooking session. 10

25. The apparatus according to claim **24** and further comprising:

a refrigerator, wherein the refrigerator includes the plug, wherein the plug is connected to the electrical connector. 15

26. The apparatus according to claim **25**

wherein the microwave oven further includes at least one USB port,

wherein the at least one USB port is in operative connection with the at least one power control circuit. 20

27. The apparatus according to claim **26**, and further comprising:

a safe, wherein the safe is in operative connection with the at least one power control circuit.

28. The apparatus according to claim **27** 25

wherein the safe includes

a safe body, wherein the safe body bounds a safe interior area, wherein the safe interior area is externally accessible through a safe opening,

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a safe door, wherein the safe door is movably mounted in operative supported connection with the safe body, wherein the safe door is movable between a closed position in which the safe door closes the safe opening and an open position in which the safe door is at least partially disposed away from the safe opening,

a lock, wherein the lock is changeable responsive to at least one electrical signal, between a locked condition and an unlocked condition, wherein in the closed position of the safe door the lock in the locked condition is operative to prevent the safe door from being moved to the open position,

wherein the microwave oven includes at least one user input device configured to receive manual inputs from users,

wherein the microwave oven is operable to provide cooking power usable by the magnetron to cook items in the cooking area responsive at least in part to inputs through the at least one user input device,

wherein the at least one user input device is in operative connection with the lock,

wherein the lock is enabled to be changed from the locked condition to the unlocked condition responsive at least in part to at least one input to the at least one user input device.

* * * * *

EXHIBIT 6
US Patent No. 11,677,666

(12) **United States Patent**
Hall et al.

(10) **Patent No.:** **US 11,674,746 B2**
(45) **Date of Patent:** **Jun. 13, 2023**

(54) **MULTIPLE LINKED APPLIANCE WITH
AUXILIARY OUTLET**

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Dennis O'Brien, Guelph (CA)

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Foxborough, MA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/691,628**

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(65) **Prior Publication Data**

US 2022/0196319 A1 Jun. 23, 2022

Related U.S. Application Data

(63) Continuation of application No. 16/671,383, filed on
Nov. 1, 2019, now Pat. No. 11,274,876, which is a
(Continued)

(51) **Int. Cl.**
F25D 23/12 (2006.01)
H05B 6/66 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **F25D 23/12** (2013.01); **F25D 29/005**
(2013.01); **H05B 6/666** (2013.01); **H05B 6/68**
(2013.01)

(58) **Field of Classification Search**

CPC H05B 6/642; H05B 6/6435; H05B 6/645;
H05B 6/6458; H05B 6/6461;

(Continued)

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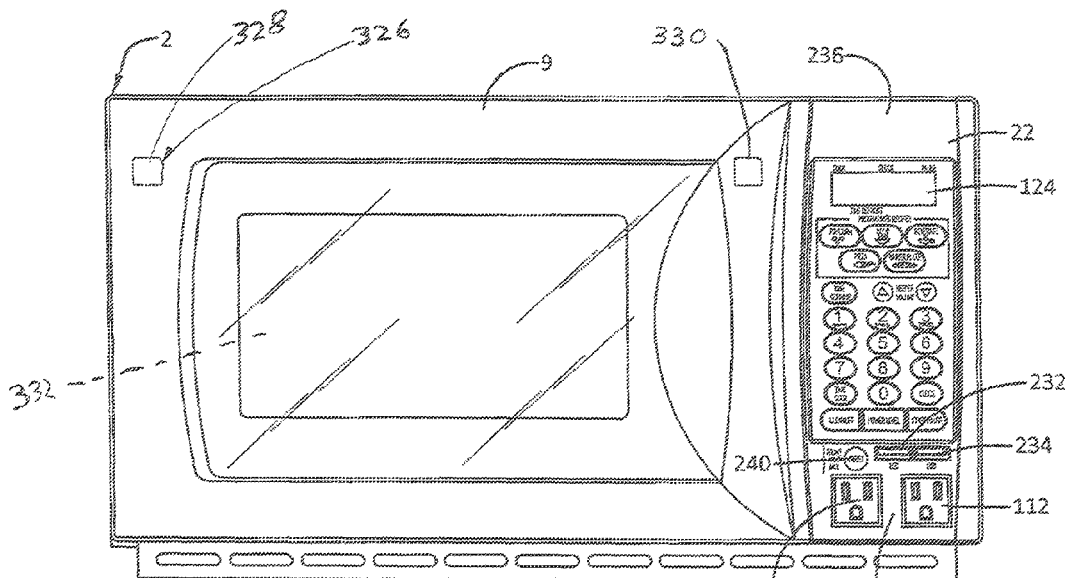
Primary Examiner — Hung D Nguyen

(74) *Attorney, Agent, or Firm* — Ralph E. Jocke; Walker
& Jocke

(57) **ABSTRACT**

A combination microwave and refrigerator system is provided. The microwave oven is connected to a source of power and has a control circuit for controlling the operation of the microwave oven. A first power supply outlet is provided on the microwave oven. A refrigerator is connected to the source of power by connection to the first power supply outlet. The control circuit is configured to disable the cooling operation of the refrigerator, when the microwave oven demands cooking power, and enable the cooling operation of the refrigerator when the microwave oven is not drawing cooking power. A safety sensor is provided in the microwave oven, and is configured to cause cooking power to the microwave oven to be turned off upon the safety sensor sensing a level of smoke.

24 Claims, 25 Drawing Sheets



Related U.S. Application Data

continuation-in-part of application No. 15/600,118, filed on May 19, 2017, now Pat. No. 10,495,374, and a continuation-in-part of application No. 15/239,378, filed on Aug. 17, 2016, now abandoned, said application No. 15/600,118 is a continuation of application No. 15/135,883, filed on Apr. 22, 2016, now Pat. No. 9,664,436, which is a continuation-in-part of application No. 12/317,632, filed on Dec. 23, 2008, now Pat. No. 8,742,304.

- (60) Provisional application No. 62/262,954, filed on Dec. 4, 2015, provisional application No. 62/211,765, filed on Aug. 29, 2015, provisional application No. 61/009,419, filed on Dec. 28, 2007.

- (51) **Int. Cl.**
F25D 29/00 (2006.01)
H05B 6/68 (2006.01)

(58) **Field of Classification Search**

CPC H05B 6/6482; H05B 6/66; H05B 6/666;
H05B 6/68; H05B 6/80; H05B 6/806;
H05B 6/808; F25D 23/003; F25D 23/12;
F25D 29/005; F25D 31/005
USPC 219/482, 488, 678, 679, 695, 697, 702,
219/715, 716, 717, 718, 719, 720, 721,
219/722, 723, 756, 757, 760, 761
See application file for complete search history.

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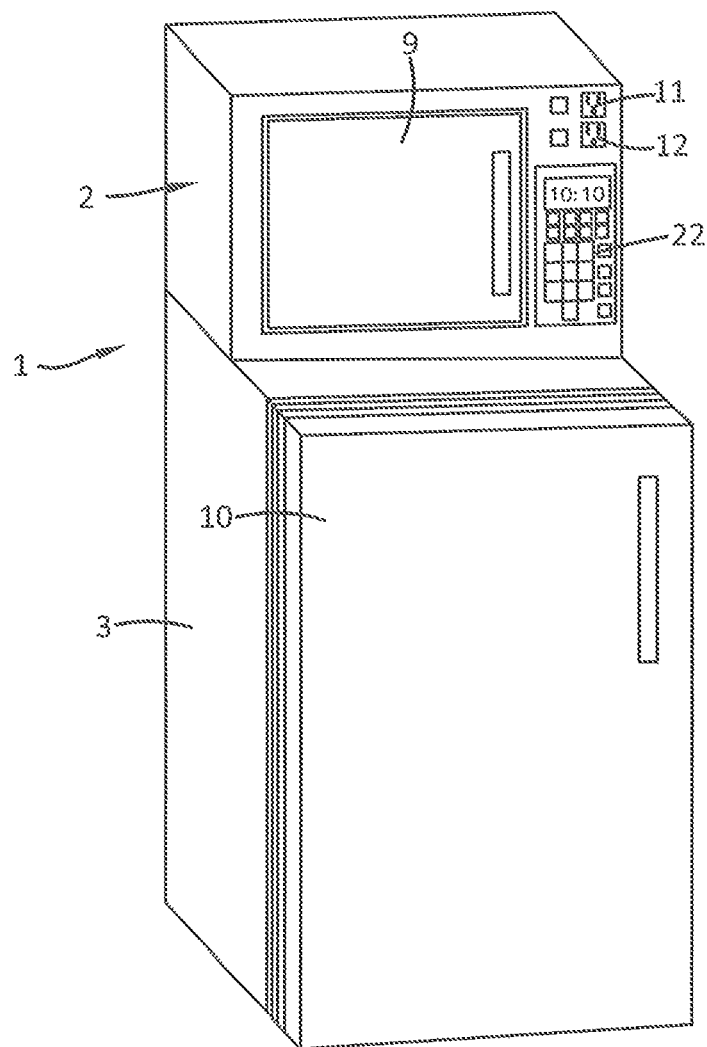


FIGURE 1

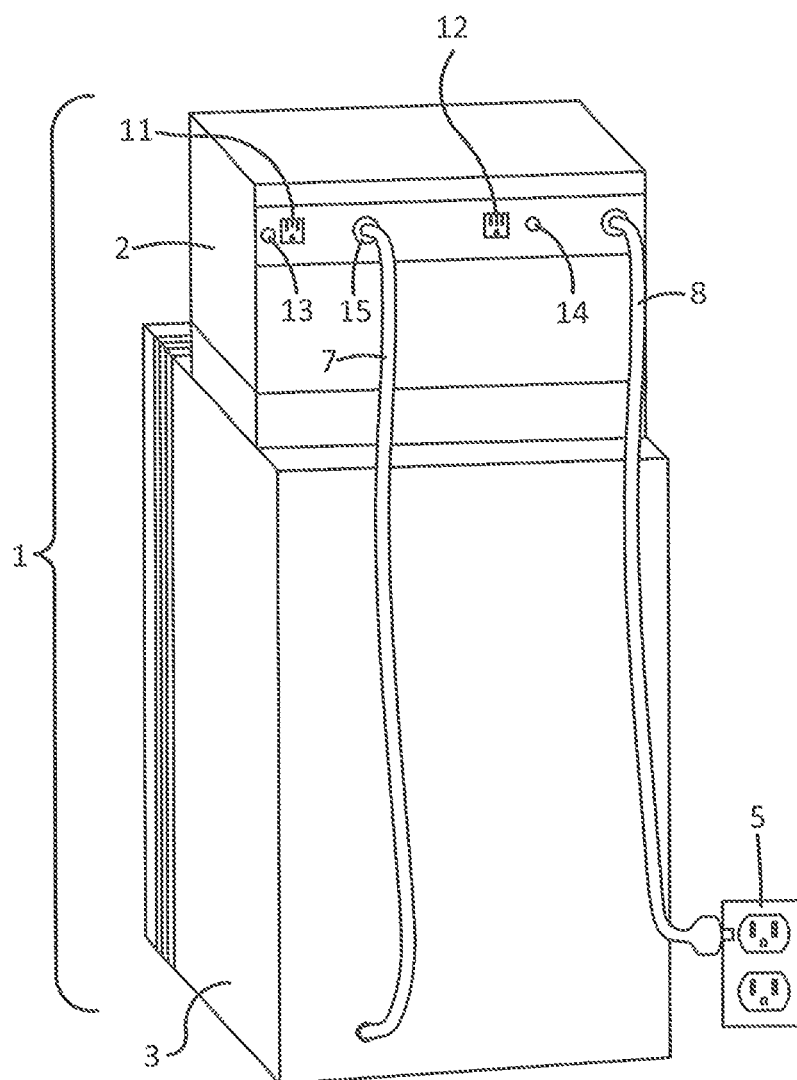


FIGURE 2

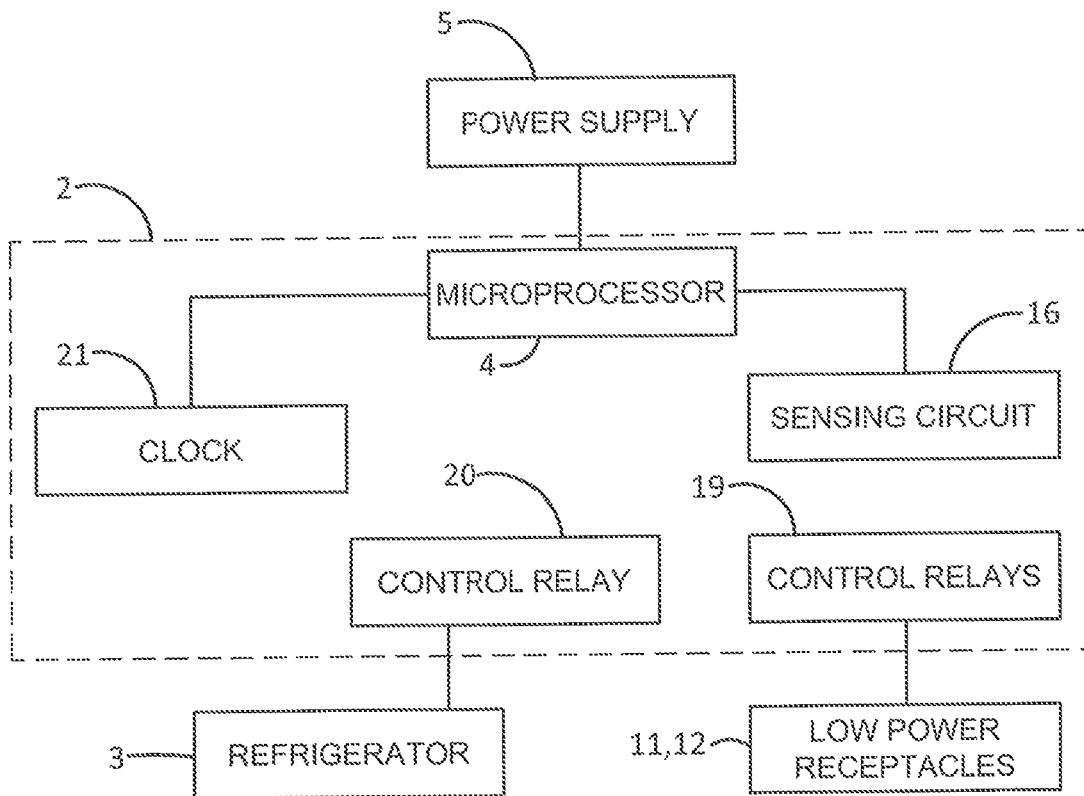


FIGURE 3

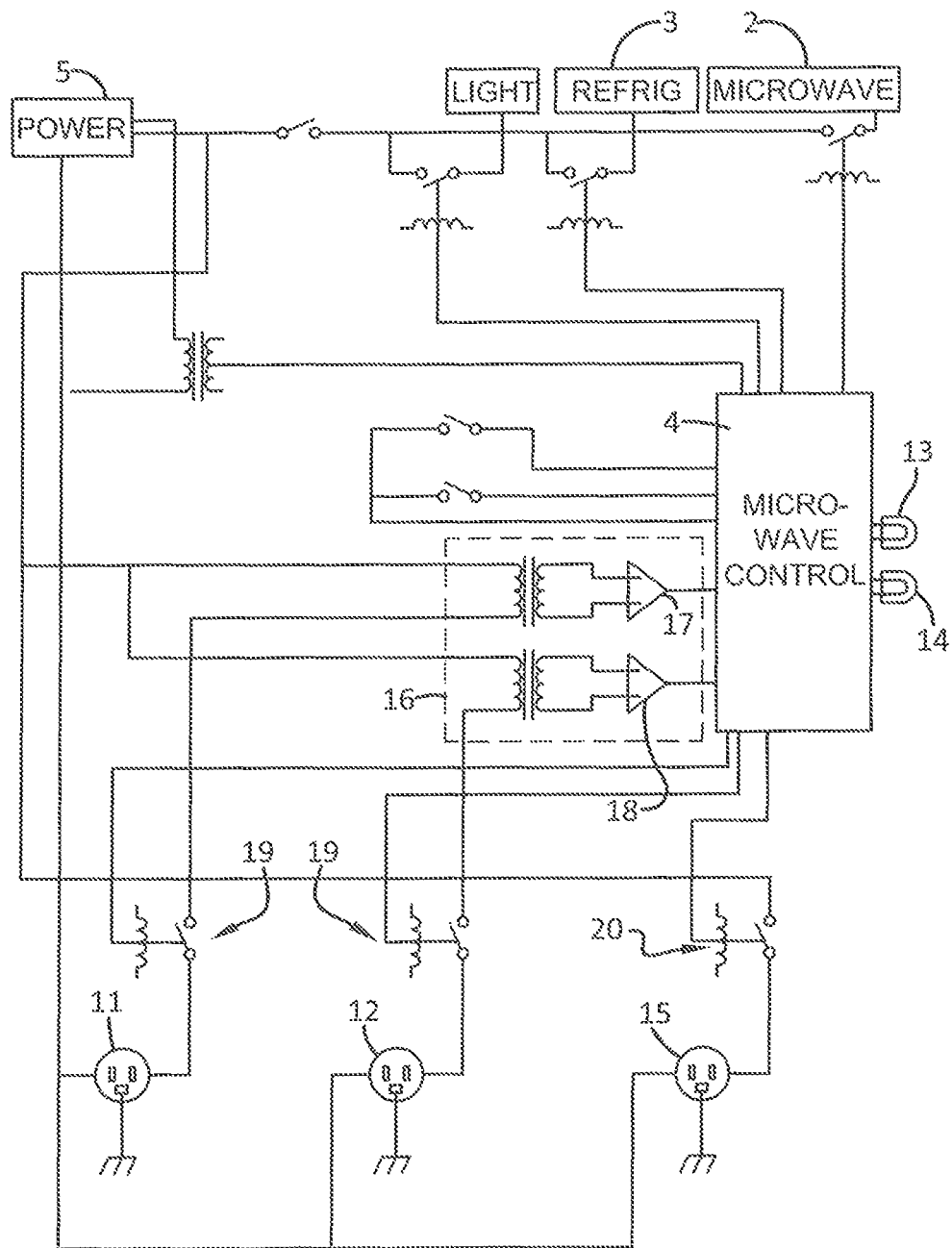


FIGURE 4

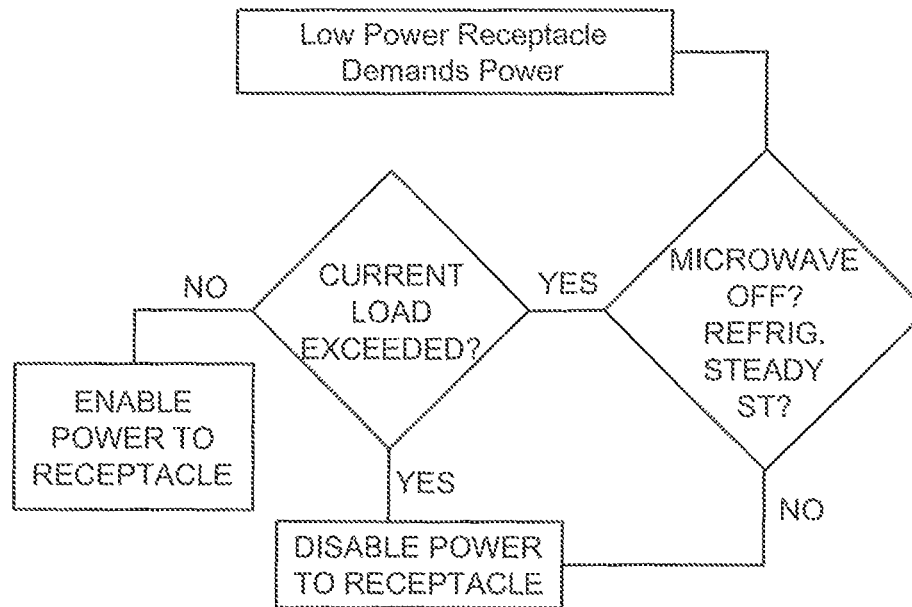


FIGURE 5

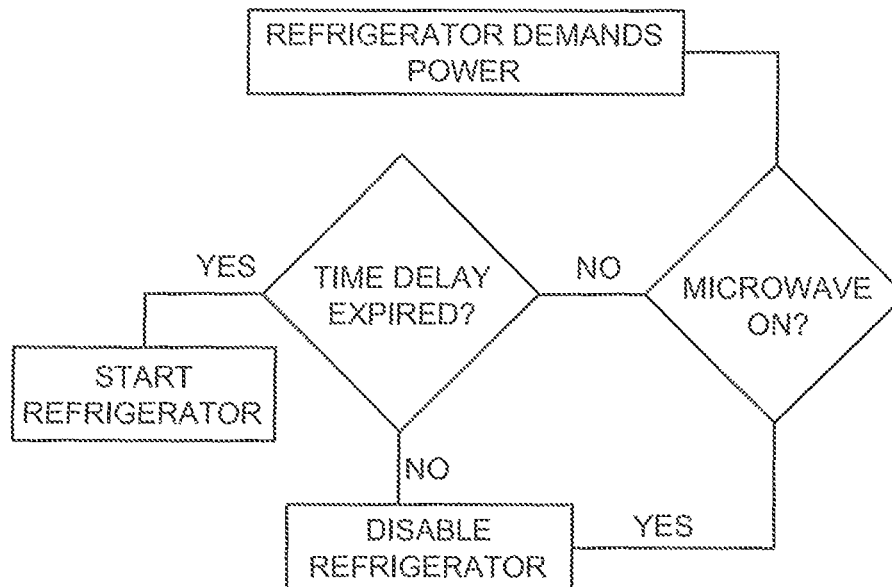


FIGURE 6

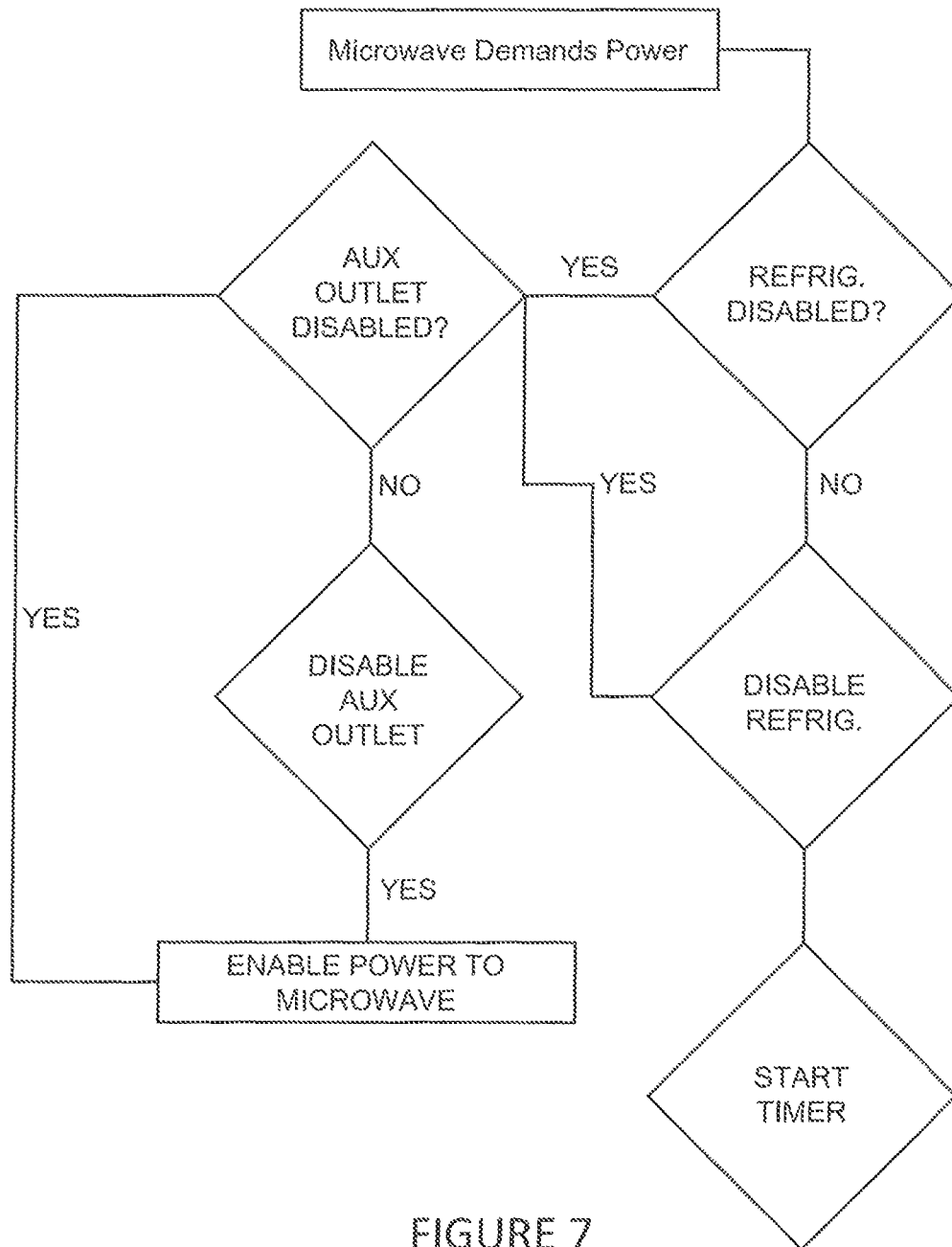


FIGURE 7

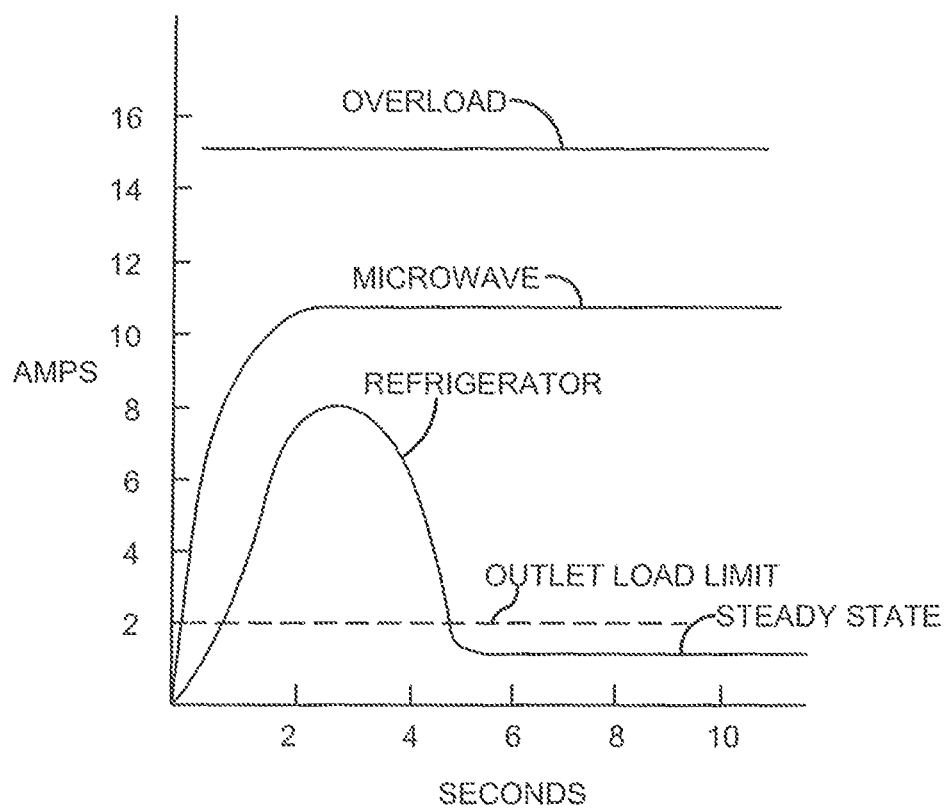


FIGURE 8

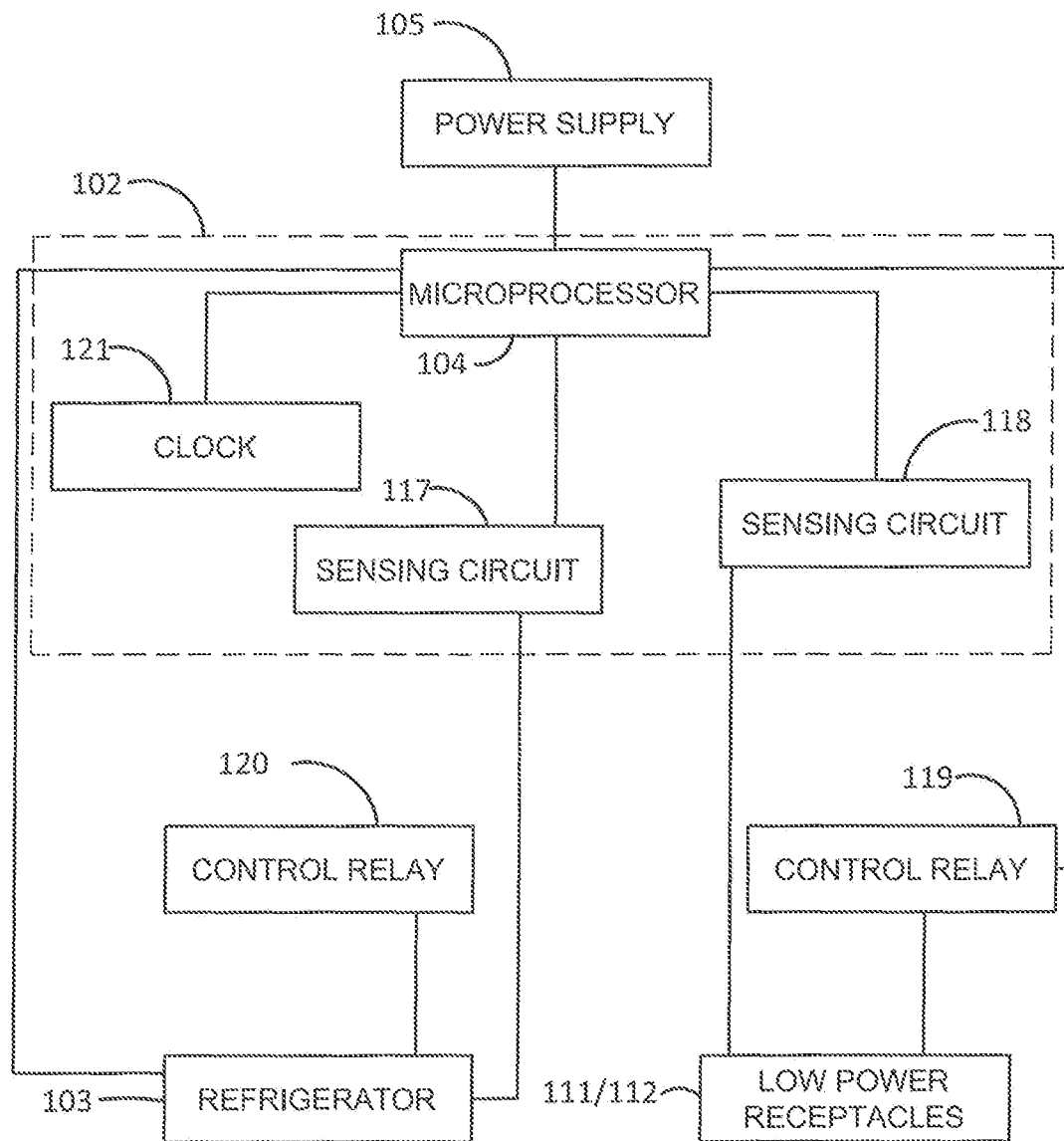
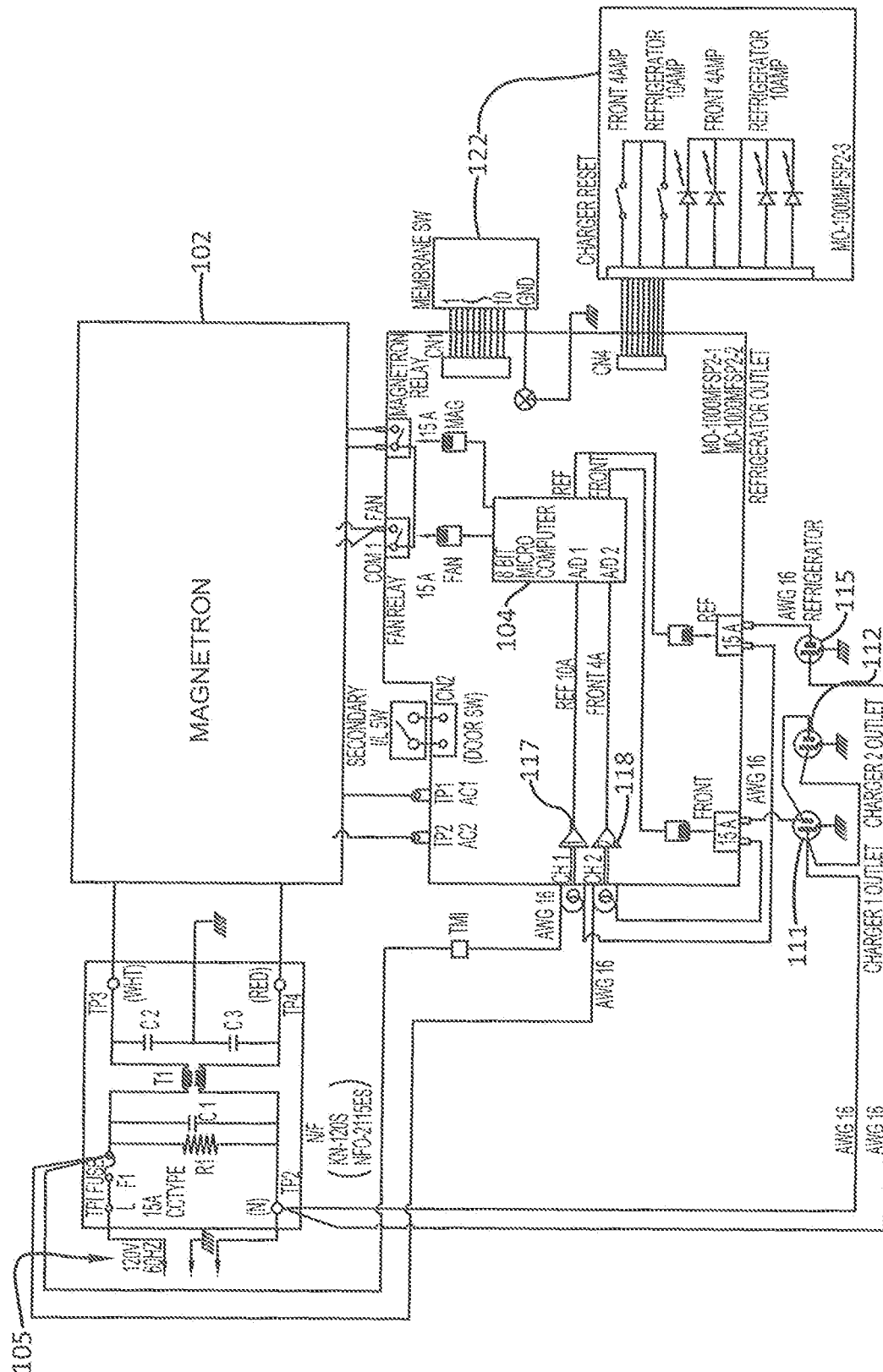
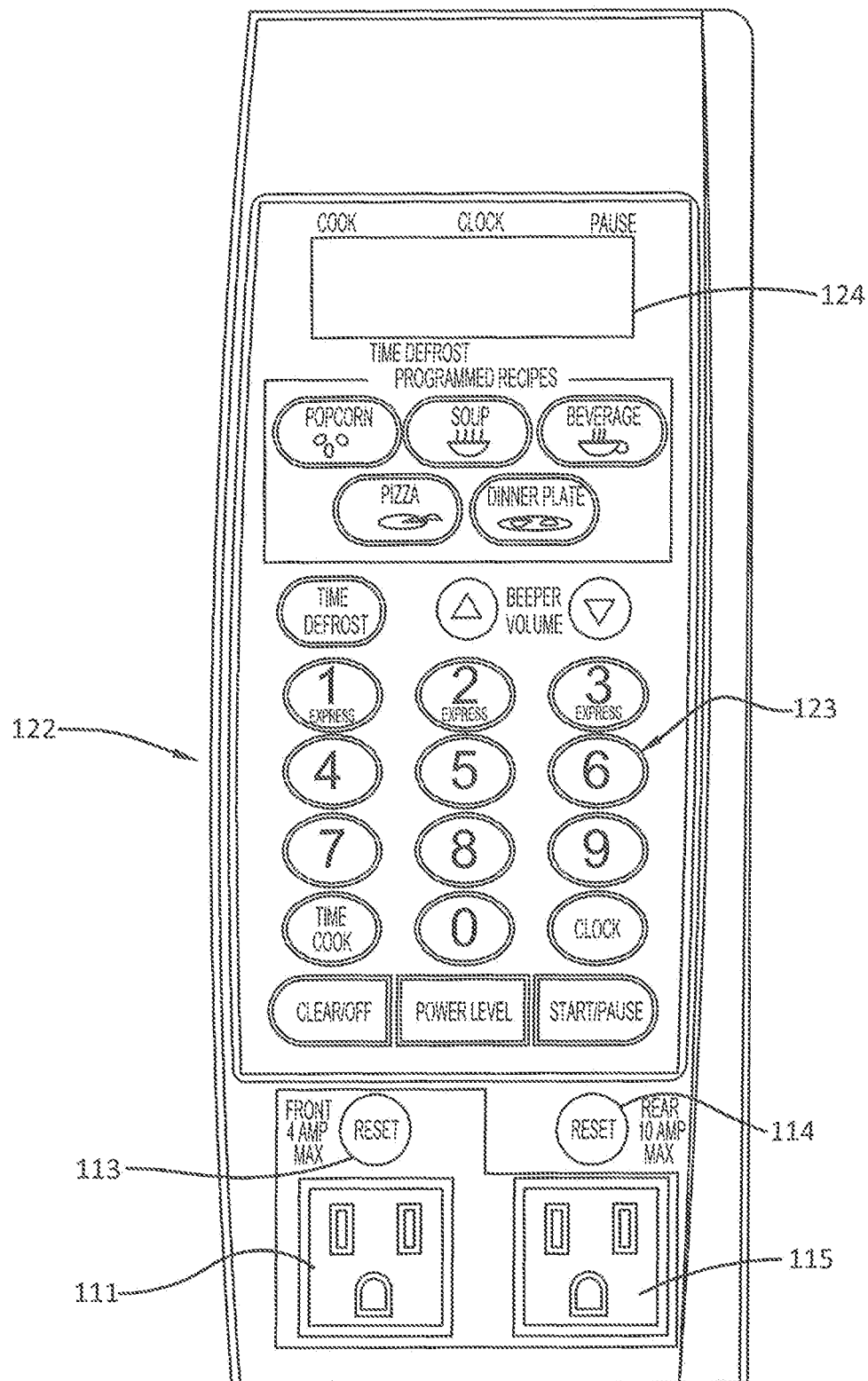


FIGURE 9



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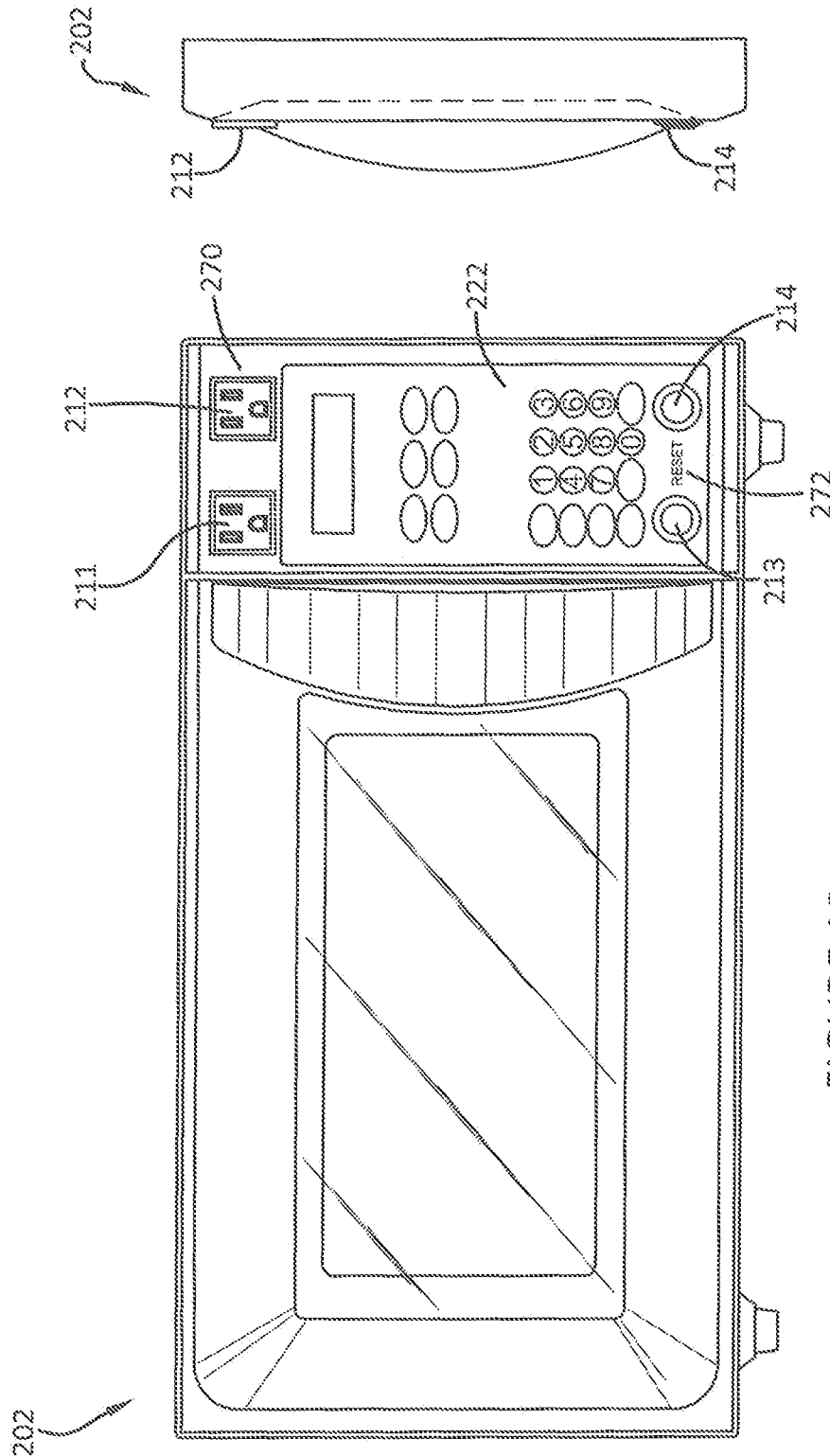


FIGURE 13

FIGURE 12

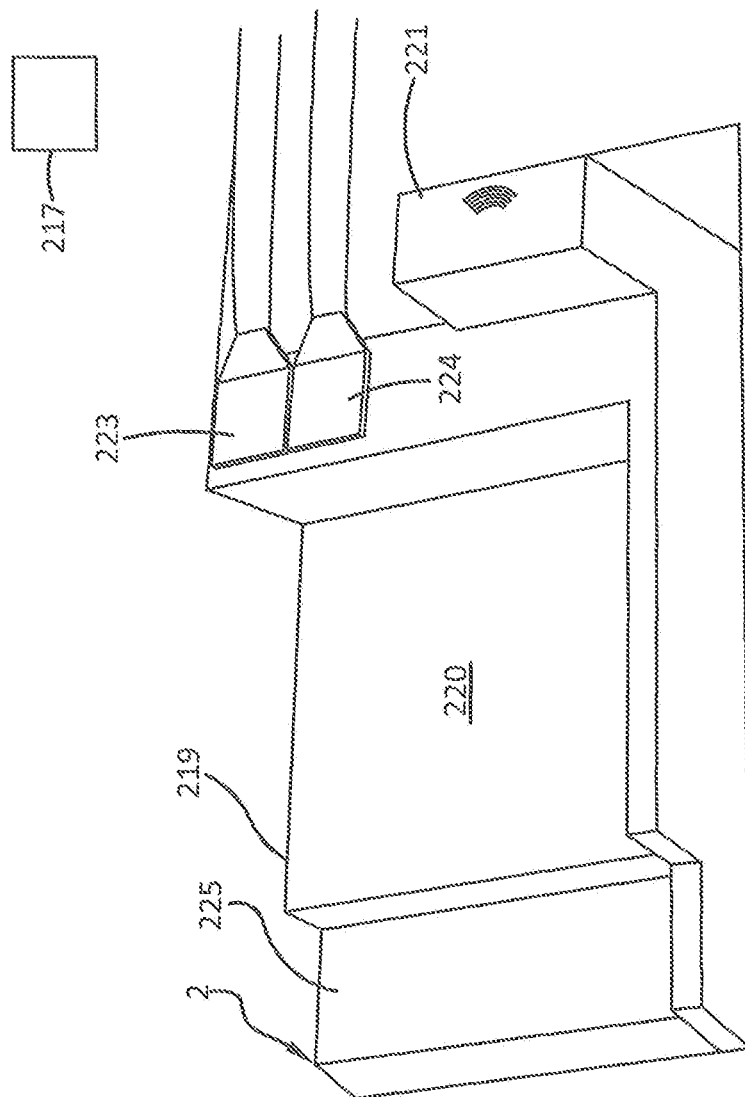
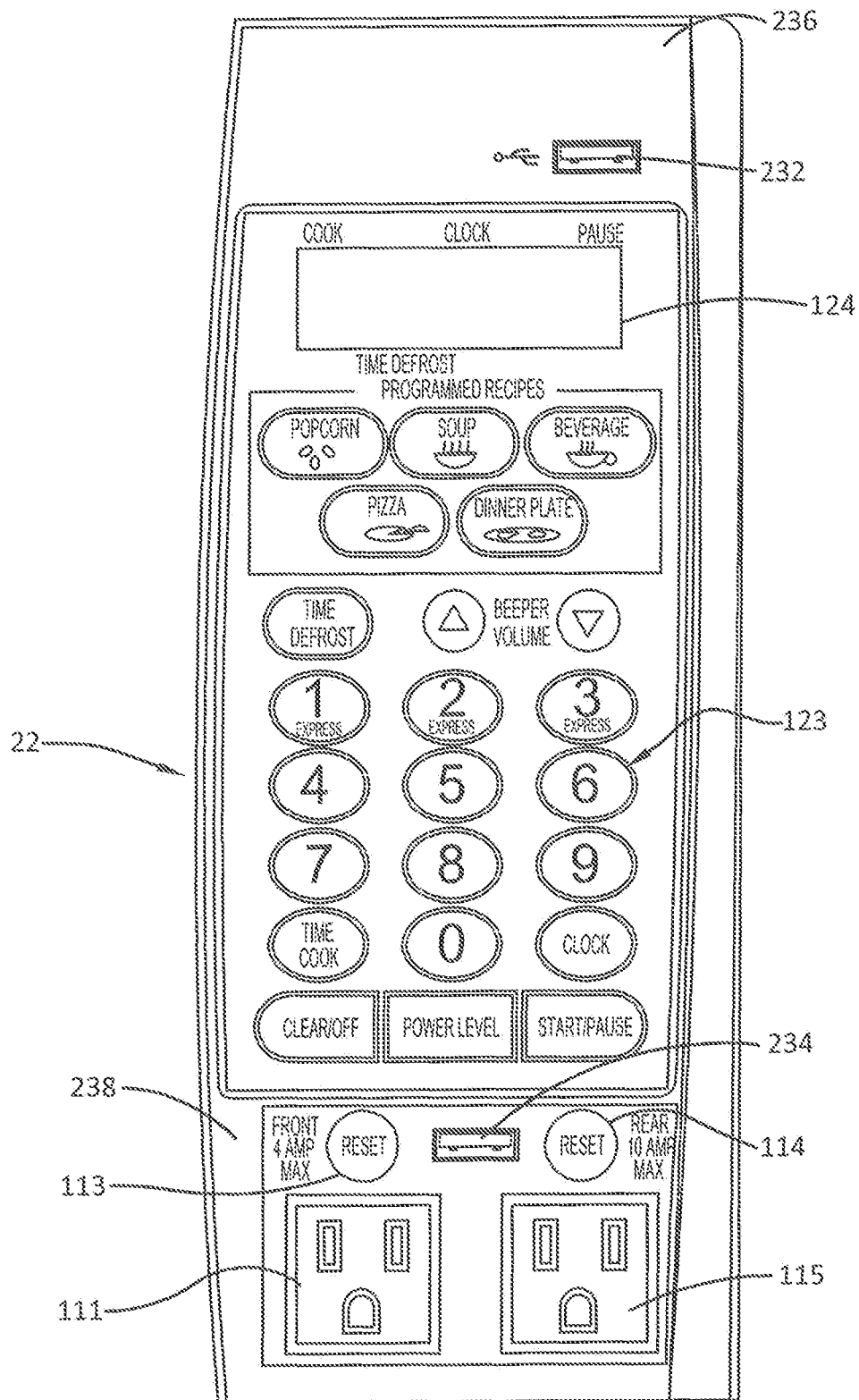
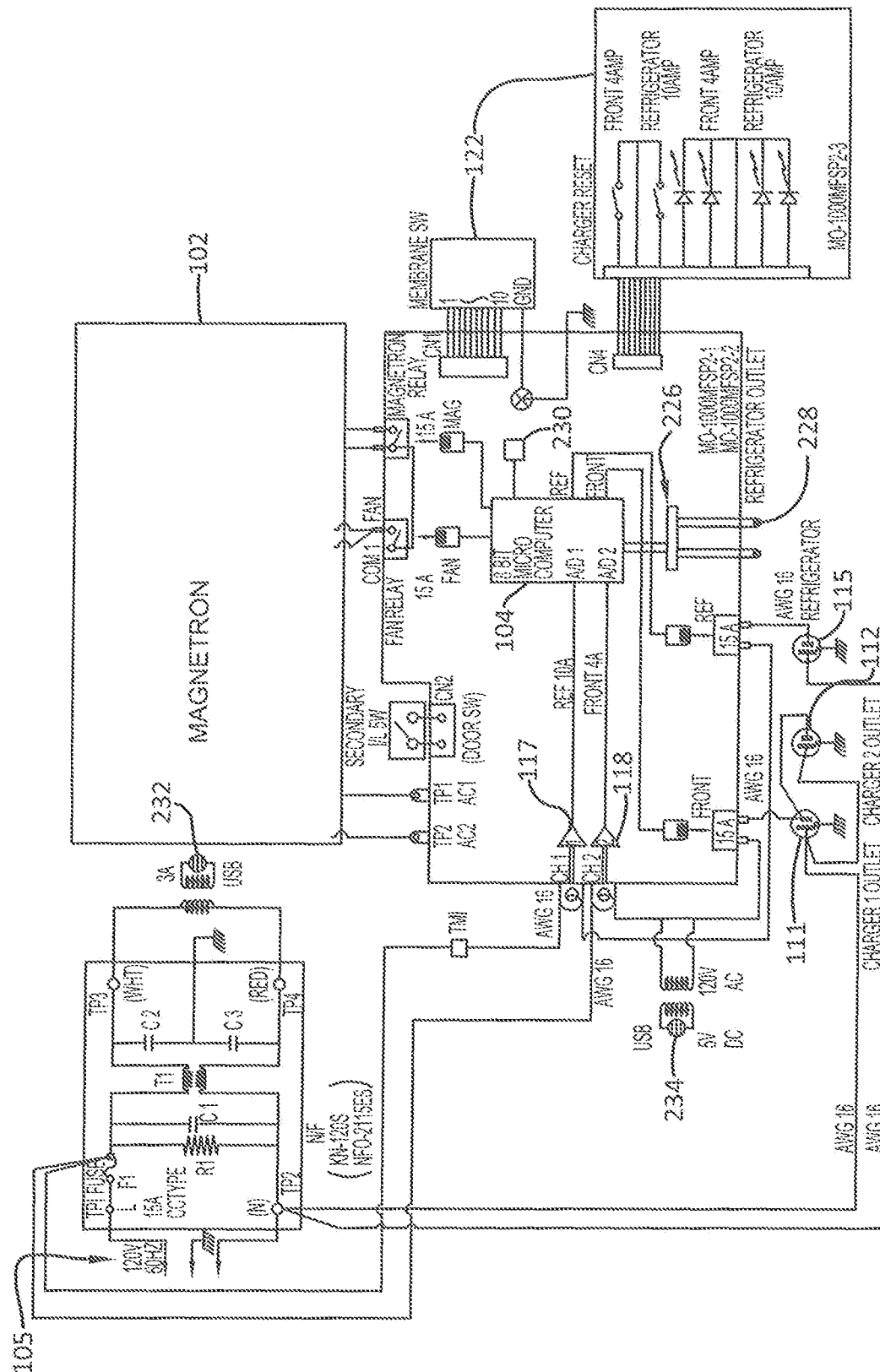


FIGURE 14





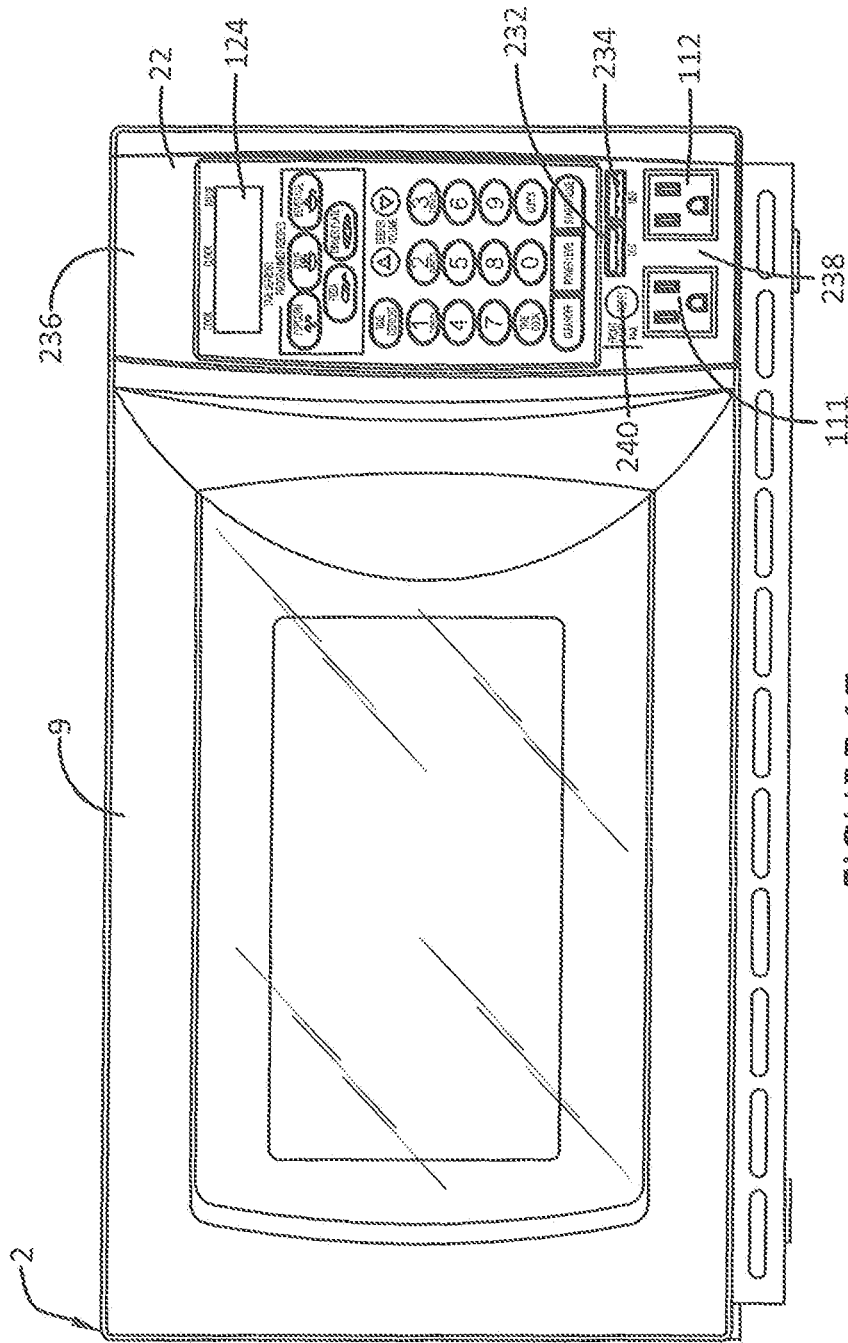
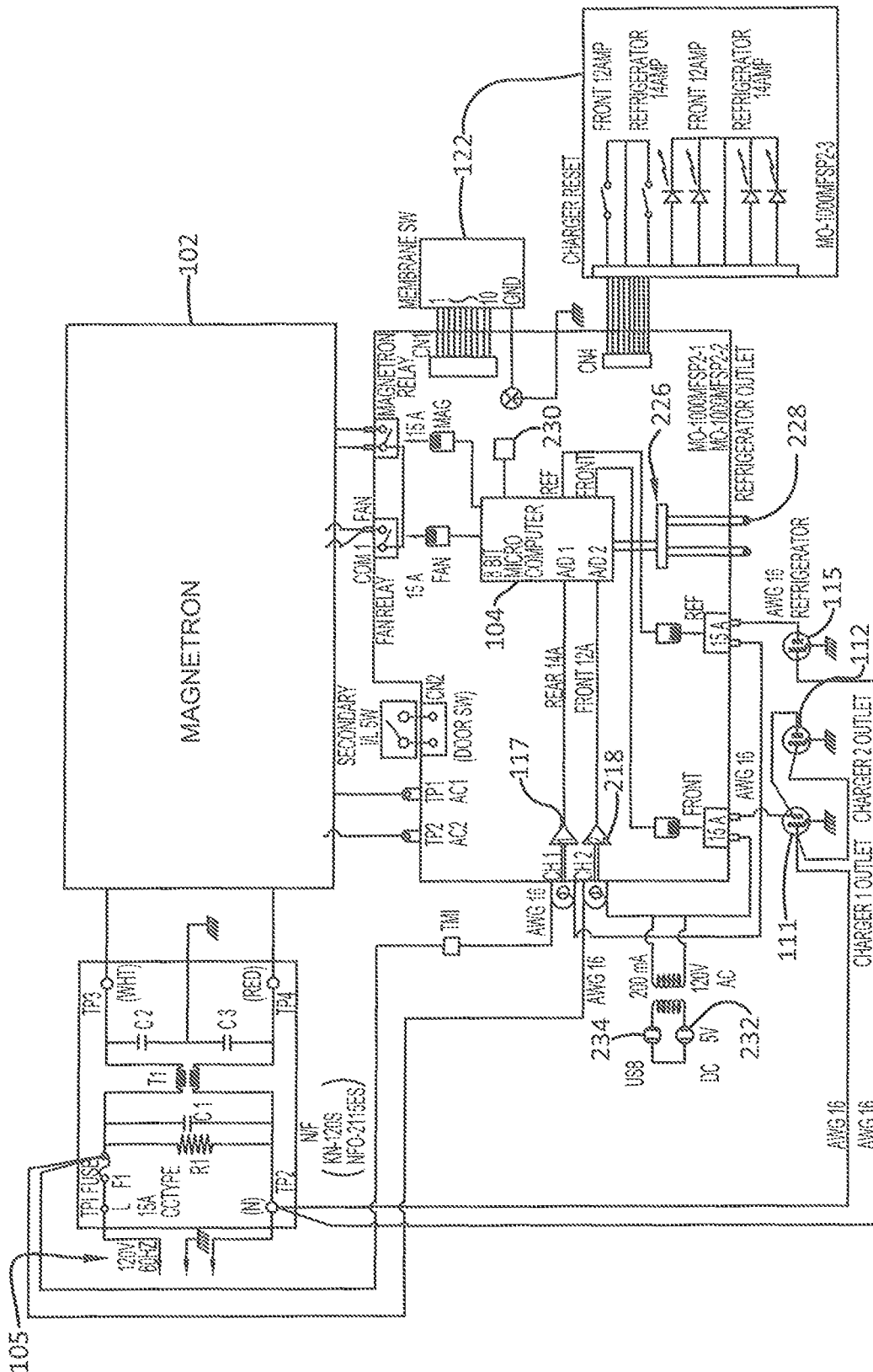
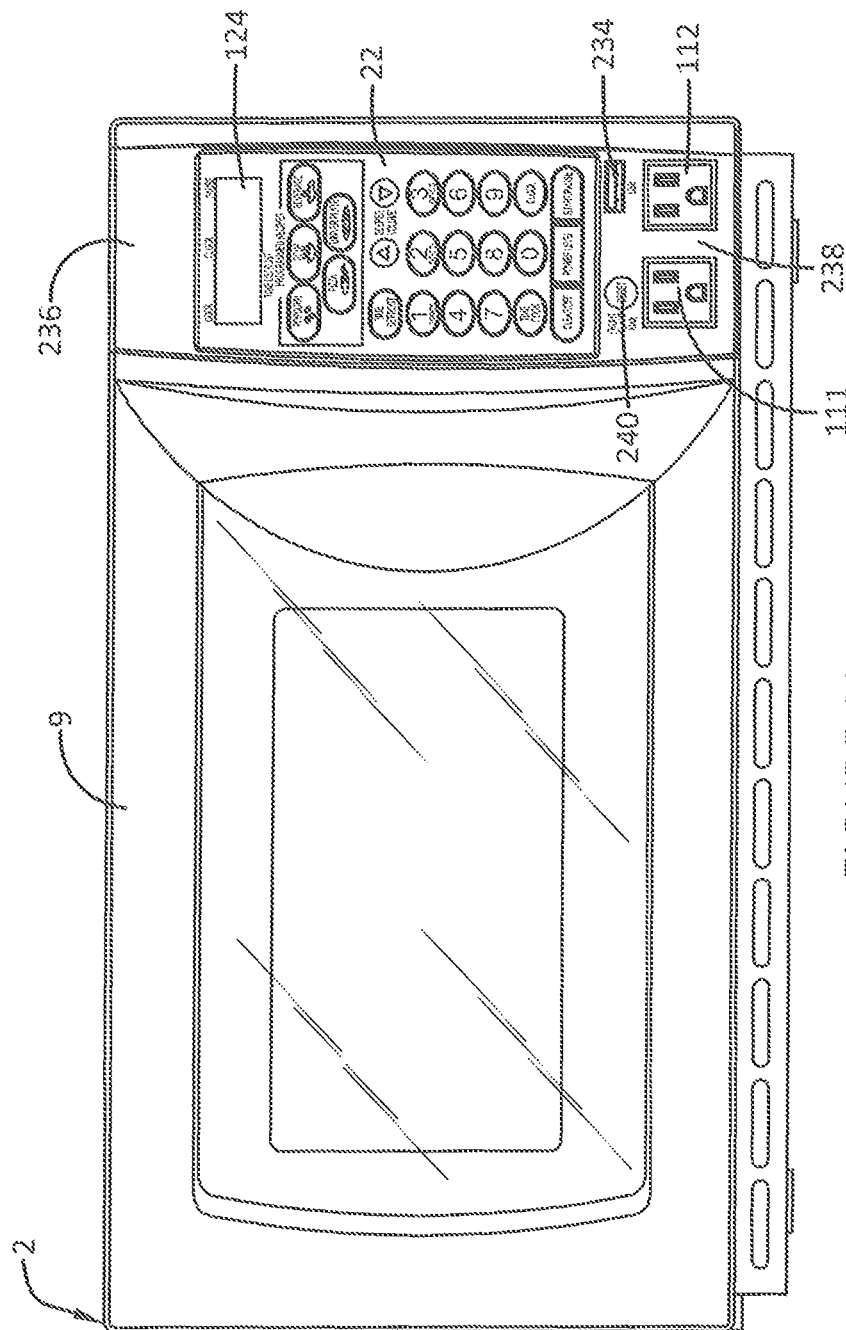


FIGURE 17



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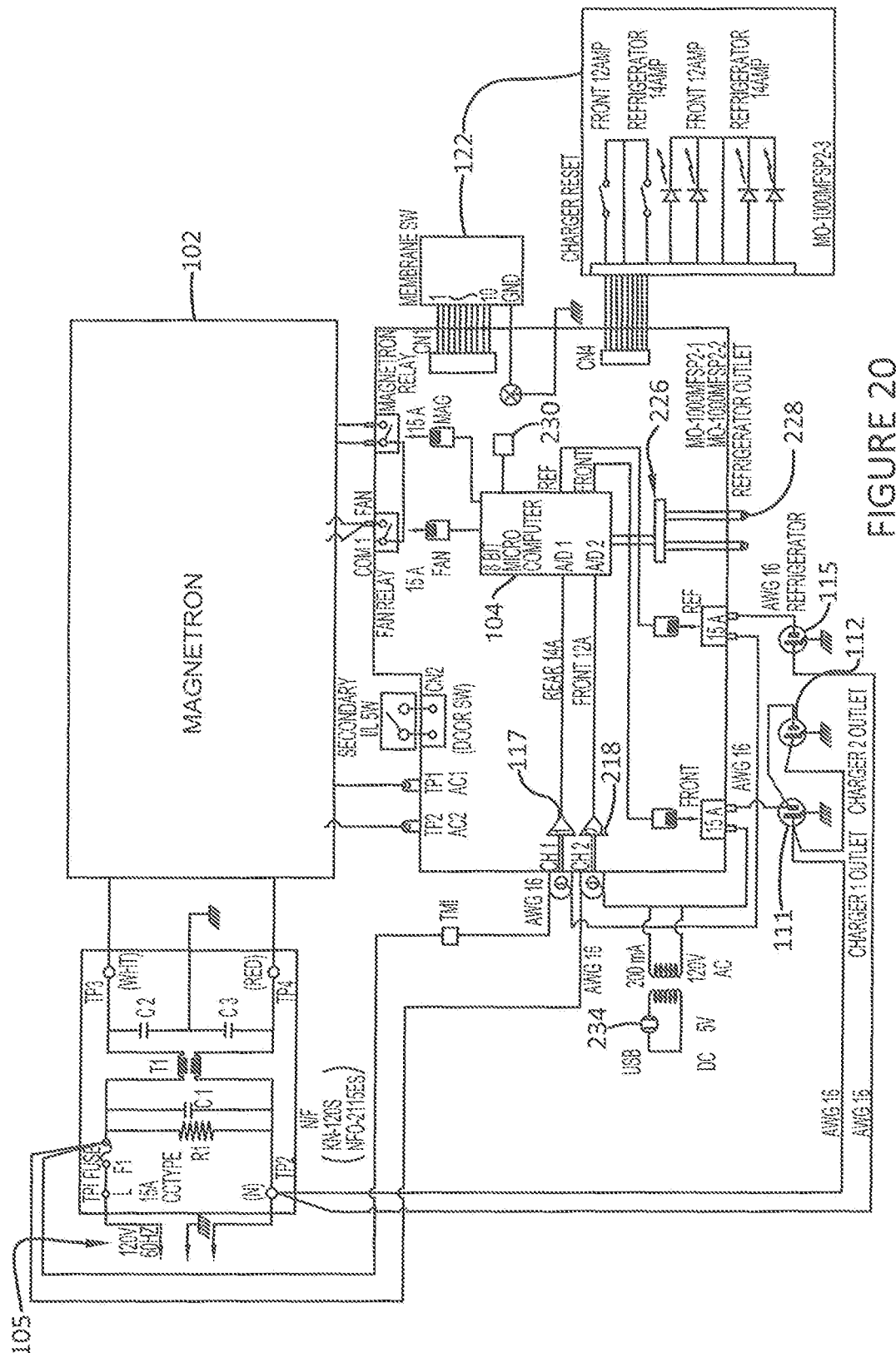


FIGURE 20

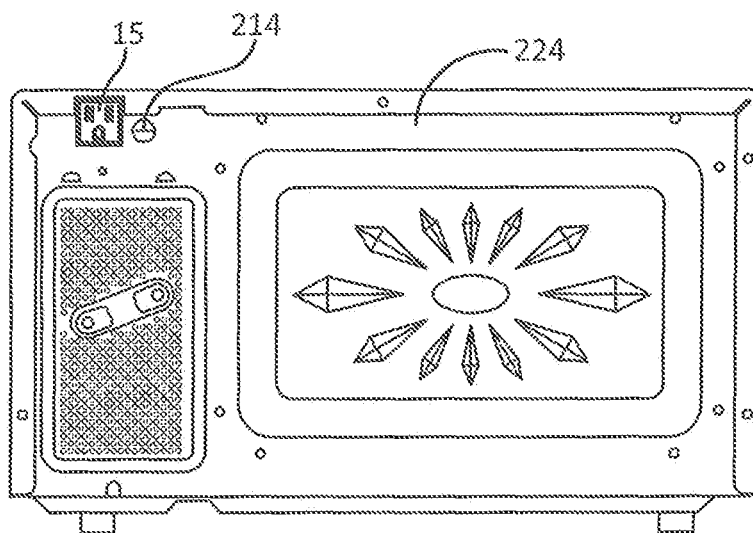


FIGURE 21

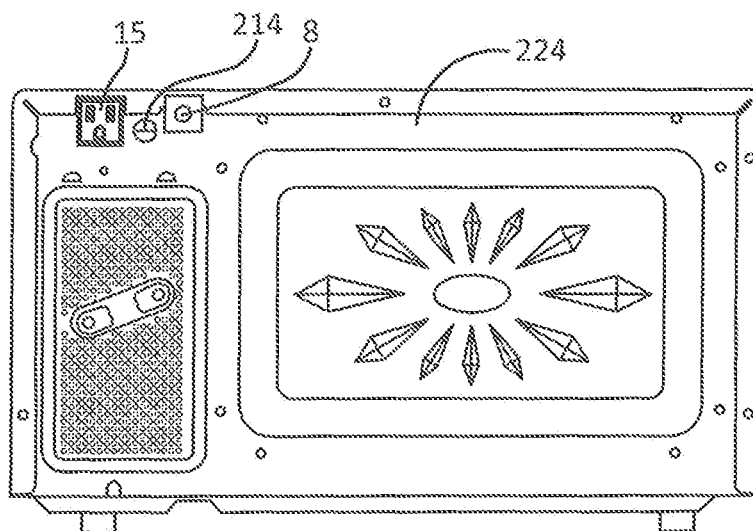


FIGURE 22

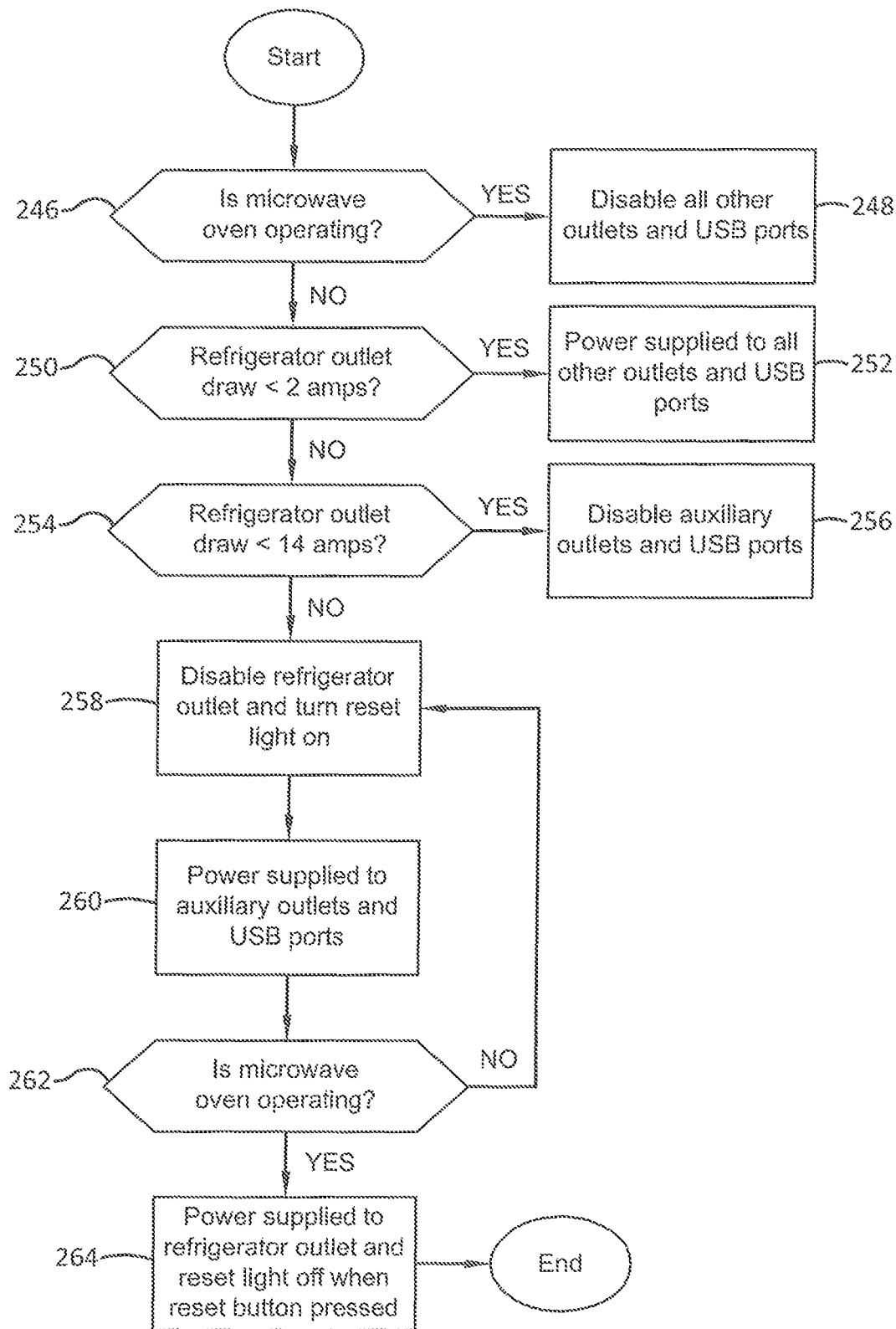
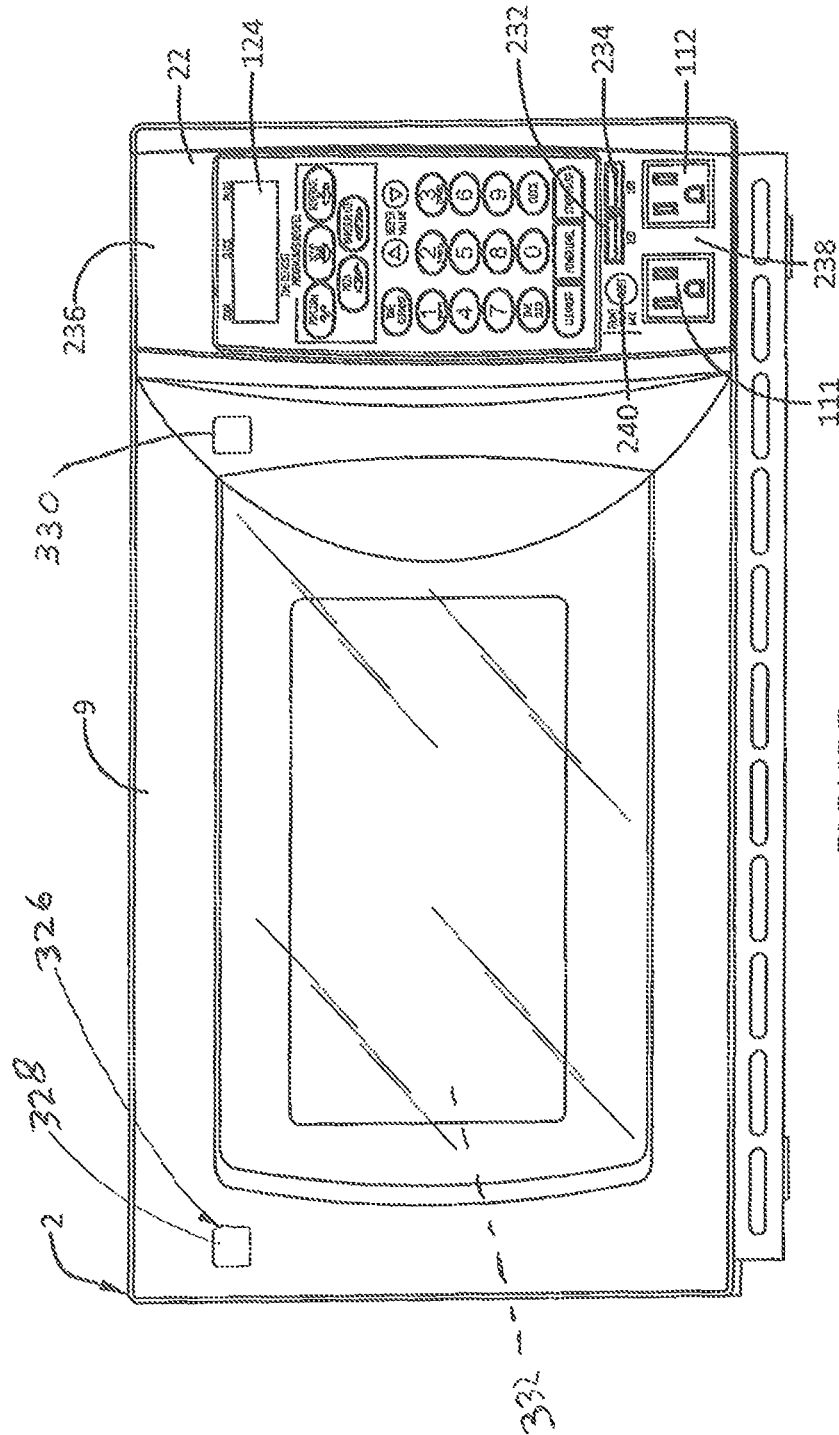


FIGURE 23



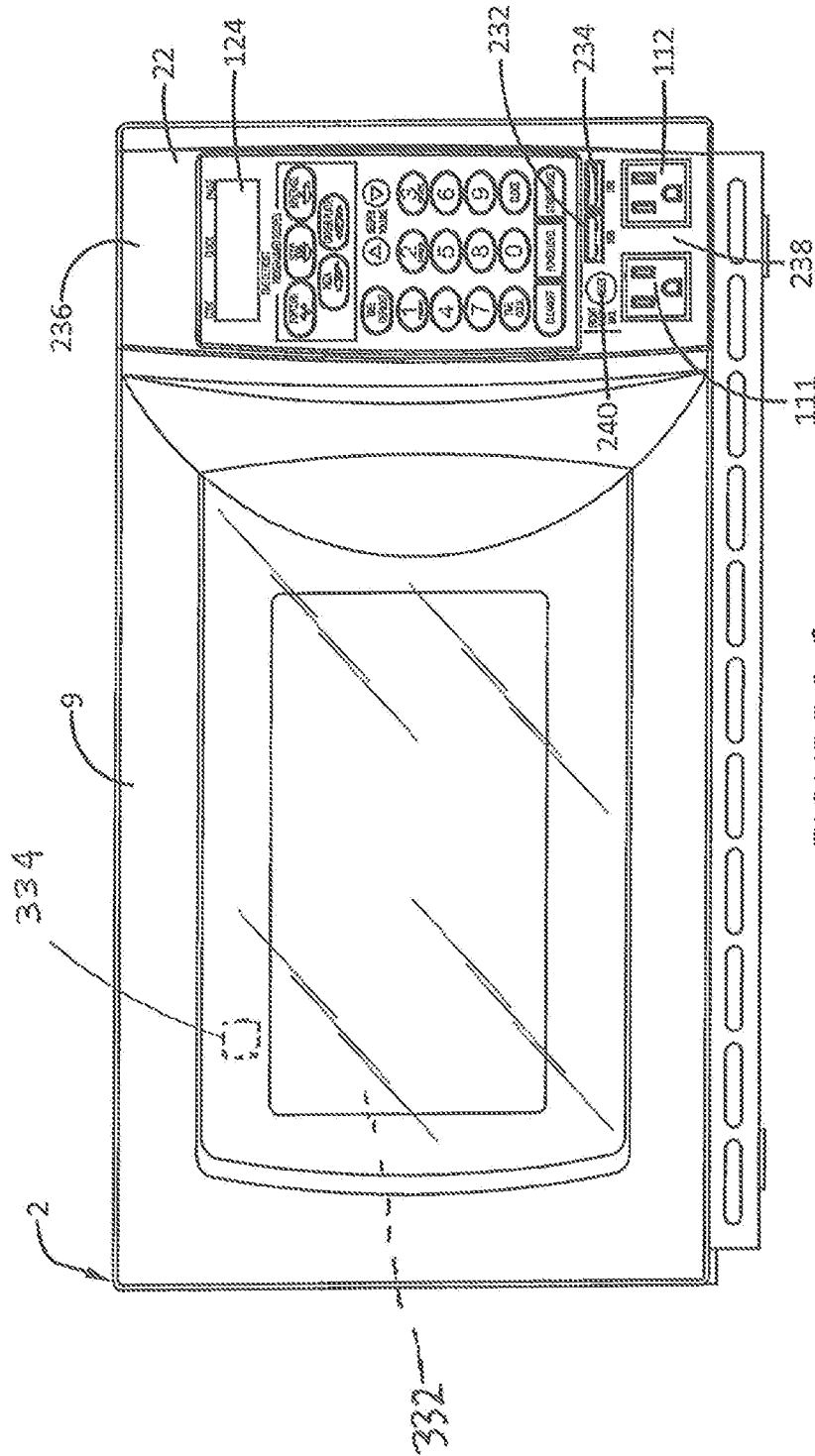


FIGURE 2.5

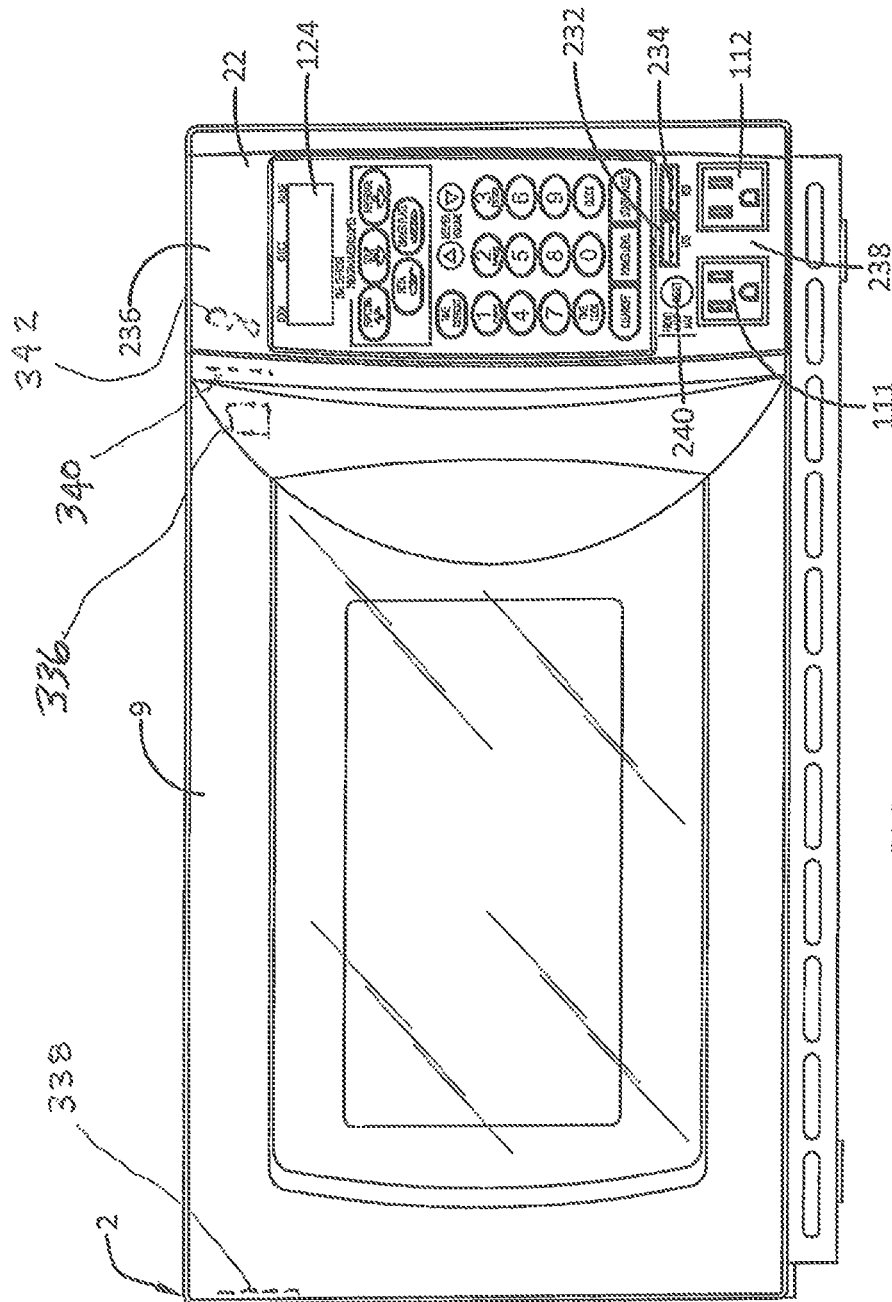
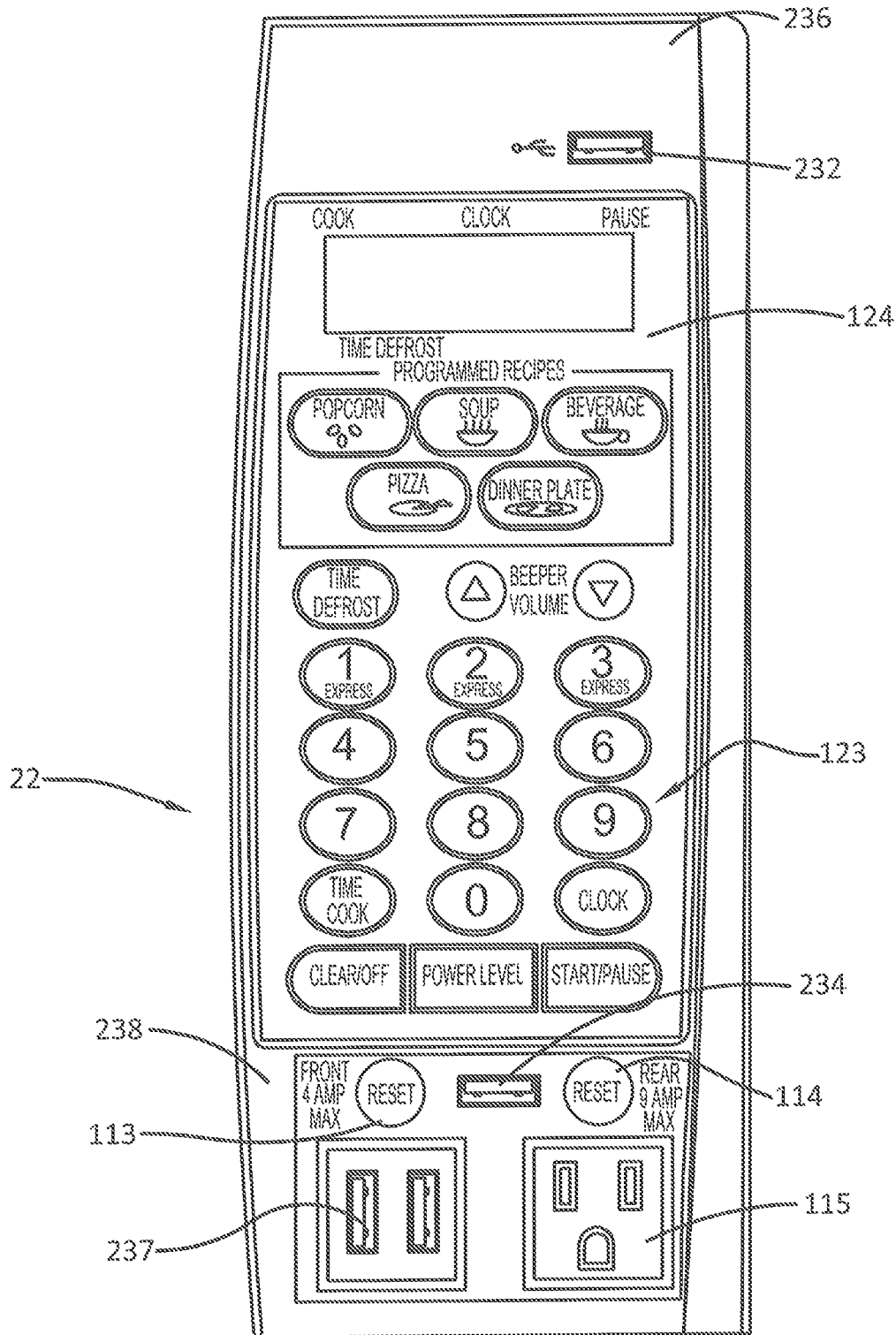


FIGURE 26



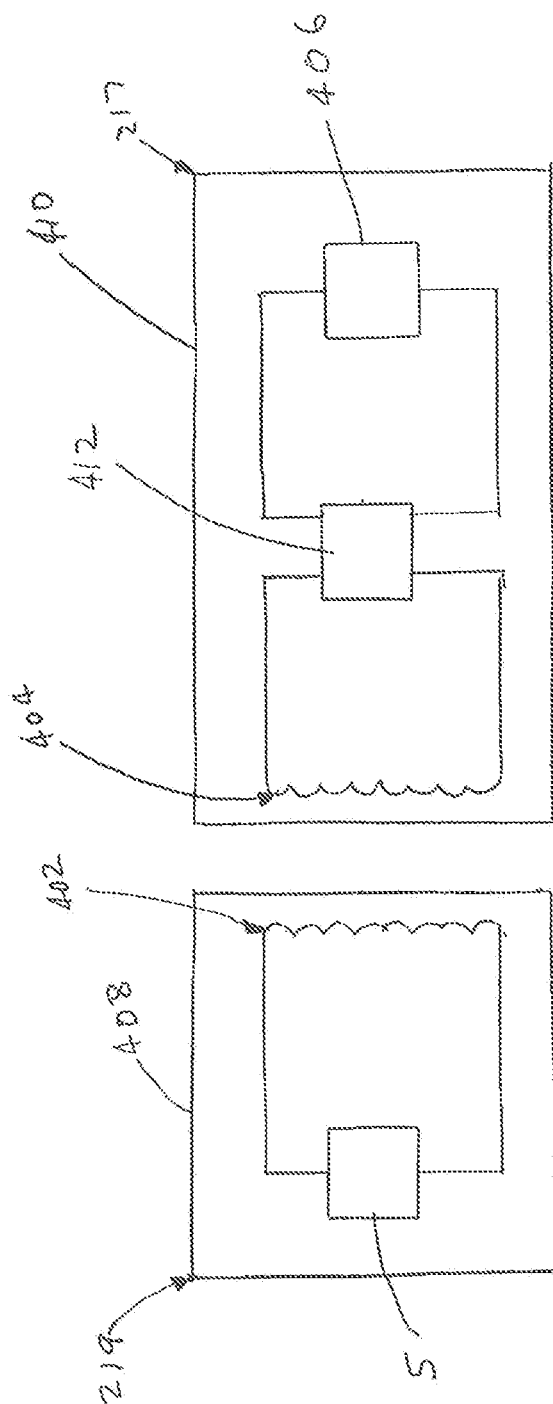


FIGURE 28

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MULTIPLE LINKED APPLIANCE WITH AUXILIARY OUTLET

TECHNICAL FIELD

Exemplary embodiments relate to improvements to appliances. Specifically, exemplary embodiments relate to improvements to appliances that include compact refrigerator and microwave oven functionality.

BACKGROUND

Compact refrigerators are used for many different purposes. They are often found in dormitories, hotels, offices and other establishments. Compact refrigerators are also often used in housing units for storage of beverages in bar areas or entertainment areas. Compact refrigerators provide useful storage for refrigerated items without the requirement for the considerable floor space and power draw that is required for a full size refrigerator.

Compact refrigerators and associated appliances may benefit from improvements.

SUMMARY

In one exemplary arrangement, an appliance apparatus is provided that includes a microwave oven. The microwave oven includes a radiation emitting microwave element and a microwave housing. The microwave housing bounds a cooking interior area. The radiation emitting microwave element is operative to irradiate the cooking interior area. The apparatus also includes a refrigerator. The refrigerator includes refrigerator housing. The refrigerator housing bounds a cooled refrigerator interior area. The refrigerator housing is in fixed operative mechanical connection with the microwave housing. The refrigerator includes a refrigerant compressor, or other refrigeration technology. The refrigerant compressor is operative to compress a refrigerant material. The refrigerant material is operative to cause cooling of the cooled refrigerator interior area. The apparatus includes at least one power control circuit. The at least one power control circuit is operative to cause electrical power to be selectively delivered to the microwave element and the compressor. One of the microwave element and compressor does not operate when the other of the microwave element and the compressor operates. A charging pad is provided on the microwave oven. The charging pad is configured for receiving an item to be charged by the charging pad. The microwave oven further includes at least one smoke sensor. In exemplary arrangements different types of smoke sensors may be used. An exemplary sensor includes a sensor emitter and at least one sensor receiver configured to receive radiation from the at least one smoke sensor emitter, wherein air of at least a portion of the cooking interior area extends intermediate of the at least one sensor emitter and the at least one sensor receiver. The apparatus also includes at least one safety circuit. The at least one safety circuit is in operative connection with the at least one sensor emitter, the at least one sensor receiver, and the microwave element. The at least one safety circuit is operative to cause the at least one sensor emitter to emit sensor radiation and the at least one sensor receiver to sense sensor radiation from the at least one sensor emitter while the microwave element operates during a cooking session. A determination is made that a transmission amount of sensor radiation from the at least one sensor emitter that reaches the at least one sensor receiver has fallen by at least a threshold amount during the cooking session,

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due to smoke in the cooking interior area. Responsive at least in part to the determination, the microwave element is no longer supplied with electrical power. Other features may be included in exemplary arrangements.

BRIEF DESCRIPTION OF THE DRAWINGS

The system of the application is explained in more detail below with reference to the accompanying drawings, in which:

FIG. 1 is a front perspective view of an exemplary arrangement of an appliance system.

FIG. 2 is a rear perspective view of the arrangement of FIG. 1 showing an alternative arrangement.

FIG. 3 is a schematic block diagram of an arrangement of the exemplary system.

FIG. 4 is an electrical schematic diagram corresponding to the arrangement of FIG. 3.

FIG. 5 is a schematic logic flow diagram of an exemplary arrangement.

FIG. 6 is a schematic logic flow diagram of another exemplary arrangement.

FIG. 7 is a schematic logic flow diagram of another arrangement.

FIG. 8 is a graph illustrating the duty cycles of the components of the appliance in the system of FIG. 3.

FIG. 9 is a block diagram of an alternate arrangement.

FIG. 10 is an electrical schematic diagram of the arrangement of FIG. 9.

FIG. 11 is an illustration of a control panel of the arrangement of FIG. 9.

FIG. 12 is a front view of the microwave oven according to another arrangement.

FIG. 13 is a side view of the microwave oven door of FIG. 12.

FIG. 14 is a top perspective view of a charging pad on the top portion of a microwave oven.

FIG. 15 is an illustration of a control panel of an alternate arrangement.

FIG. 16 is an electrical schematic diagram of the arrangement of FIG. 15.

FIG. 17 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 18 is an electrical schematic diagram of the arrangement of FIG. 17.

FIG. 19 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 20 is an electrical schematic diagram of the arrangement of FIG. 19.

FIG. 21 is a rear view of the microwave oven according to the arrangements of FIGS. 12-19.

FIG. 22 is a similar view as that of FIG. 21 except that the AC cord is shown.

FIG. 23 is a schematic logic flow diagram of an exemplary arrangement.

FIG. 24 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 25 is a front view of the microwave oven according to another arrangement.

FIG. 26 is a front view of the microwave oven according to another exemplary arrangement.

FIG. 27 is an illustration of a control panel of an alternate arrangement.

FIG. 28 is a schematic diagram corresponding to the arrangement of FIG. 14 showing the charging pad and a device being charged.

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DETAILED DESCRIPTION

A multiple linked appliance system 1, for example, an appliance that comprises a combination microwave oven 2 and refrigerator 3 incorporating features described in the present application illustrated in the Figures. Although exemplary arrangements will be described with reference to the features shown in the drawings, it should be understood that other arrangements may have many alternate forms. In addition, any suitable size, shape or type of elements or materials could be used. The computer or controller devices described in this application may be constructed having one or several processors and one or several program product modules stored in one or several memory elements. For illustration, computer or controller components may be described as individual units by function. It should be understood, that in some instances, these functional components may be separated or combined in other components.

In the exemplary arrangements, the circuits described herein may comprise one or more circuits including processors which for purposes hereof corresponds to any electronic device that is configured via circuit executable instructions that can be implemented in either hardware circuits, software, firmware or applications that are operative to enable the circuits to process data and carry out the other actions described herein. For example, the circuits may include circuits that correspond to one or more or a combination of a CPU, FPGA, ASIC or any other integrated circuit or other type or circuit that is capable of processing data. The processors may be included in a computer, server or other type of electronic device. Further, the circuits described herein may include data stores that correspond to one or more of volatile or non-volatile memories such as random access memory, flash memory, magnetic memory, optical memory, solid state memory or other devices that are operative to store computer executable instructions and data. Computer executable instructions may include instructions in any of a plurality of programming languages and formats including, without limitation, routines, subroutines, programs, threads of execution, objects, methodologies and functions which carry out the actions such as those described herein. Structures for the circuits and processors may include, correspond to and utilize the principles described in the textbook entitled *Microprocessor Architecture, Programming, and Applications with the 8085* by Ramesh S. Gaonker (Prentice Hall, 2002), which is incorporated herein by reference in its entirety. Of course it should be understood that these circuit structures are exemplary and in other embodiments, other circuit structures for storing, processing, resolving and outputting information may be used.

In exemplary arrangements the refrigerator may be connected to a power supply that provides a connection that enables the microwave oven to be connected to the same electrical supply. A single plug, therefore, may serve to connect both appliances and the current required for each appliance may be supplied by the same supply power cord and circuit. In exemplary embodiments power may be supplied by the 110V AC current outlet.

To make this combination attractive for use in dorm rooms, hotel rooms, recreational vehicles, tractor trailer cabs, and other similar locations, it may be necessary to assure that the peak current draws of both appliances are not demanded from the supply at the same time. Many household circuits are protected from overload conditions by an automatic circuit breaker that is activated when current in the circuit exceeds the breaker rating. This is 15 amps in many circuits.

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The duty cycle of an exemplary refrigerator used in these combined appliance systems includes a current spike that occurs during the first few seconds of operation. This is the start up current for the refrigerator compressor. The current draw is considerably reduced as the compressor attains its full operational speed. In typical refrigerator appliances the peak current may be in the range of 7 to 9 amps, while the steady state current may level off at 1.4 amps or less. A microwave oven demands a relatively steady 8 to 13 amps of cooking power during operation of the cooking element. It is apparent that an overload condition may occur when both appliances are placed in operation absent suitable control circuitry.

In an exemplary arrangement, a combination microwave and refrigerator appliance system is constructed having a single electrical plug input supply. The electrical supply in the exemplary arrangement is directly connected to the microwave oven. The microwave oven is adapted to provide power to the refrigerator through a power supply outlet, and to auxiliary receptacles adapted for connection to devices that operate at a low power operation draw. The microwave oven includes at least one control circuit including a processor based controller adapted to monitor operation of the refrigerator compressor and control the power to the microwave magnetron cooking element and other components. The current draws on the low power receptacles are separately monitored for control by the microwave controller. The microwave controller is adapted to balance the duty cycles of the connected appliances in operative connection therewith to avoid overload conditions. A control logic flow is implemented internally within the circuitry of the microwave controller. A receptacle or other power connecting power supply outlet for the refrigerator and the low power auxiliary receptacle may be implemented as part of the microwave control panel on the microwave oven.

In one arrangement, the auxiliary outlets are constructed to provide low power for the purpose of recharging batteries included in cellular mobile phones, personal media devices and digital cameras, in addition to operating lap top computers and other similar low power devices. The current to the auxiliary outlets is sensed by suitable circuitry in operative connection with the microwave controller.

In another exemplary arrangement, the power to the auxiliary outlets is disabled through operation of the microwave controller when the microwave magnetron is energized or whenever the current to the auxiliary outlets exceeds a preset value.

In one exemplary arrangement, a programmed control model for control logic flow is established and executed by the microwave controller. The model is dependent on the state of operation of the microwave cooking element or elements which are referred to herein as a magnetron. As part of the exemplary control model, the power draw of the compressor is monitored to sense operation of the compressor to compress refrigerant to provide cooling. When cooking power is demanded by the microwave the compressor is disabled by having electrical power thereto withdrawn by the at least one control circuit for a preset minimum period. When power demand to the magnetron ceases, refrigerator compressor power is restored provided that the preset minimum period has expired.

In another exemplary arrangement of the control model, sensing circuits are operative to monitor current draw on the auxiliary outlets. The control model is adapted to cause the controller to disable the power to the auxiliary receptacles, if the microwave magnetron is in operation. In addition the auxiliary receptacles are disabled if a predetermined maximum

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imum current draw is sensed. Another control model is based on operation of the refrigerator and operates to disable the auxiliary receptacles when the compressor is in the start up mode. Of course these approaches are exemplary and in other arrangements, other approaches may be used. Further while in the exemplary arrangement the at least one control circuit which is included in the controller is integrated with the microwave oven, in other arrangements the controller may be integrated with the refrigerator or other device, or may be configured as a separate component.

In one aspect of an exemplary arrangement, a non-transitory processor readable medium having processor executable program instructions embodied therein for operating at least one processor of a control circuit to control an appliance system of multiple linked components including a microwave oven, a refrigerator, and an auxiliary power supply outlet is provided. The processor executable program code causes the control circuit to disable the refrigerator and the auxiliary power supply outlet, when the microwave demands high power such as magnetron cooking power, and enable power delivery from the auxiliary power supply outlet when the microwave is not drawing cooking power.

One exemplary arrangement of a multi-component interconnected appliance system 1 is illustrated in FIG. 1. This arrangement consists of two components, a refrigerator 3 and a microwave oven 2. Refrigerator 3 is electrically connected to microwave oven 2 by power cord 7 to refrigerator receptacle 15, shown at the rear of the microwave 2 in FIG. 2. Refrigerator 3 is generally subject to control by the microwave microprocessor controller which is alternatively referred to herein as a power control circuit 4 of the microwave oven 2. The power control circuit may be operative to cause electrical power to be selectively delivered to and/or withheld from the microwave magnetron and the refrigerator compressor. A single power cord 8 provides input electrical power to the system 1 from receptacle 5 which provides a source of electrical power, through microwave 2. In the case where stand alone components are used, as shown in FIGS. 1 and 2, microwave oven 2 is connected directly to power source 5. The refrigerator 3, as the heaviest component, is used as the base with the microwave oven 2 stacked on top. In the selection of the refrigerator 3, it would be advantageous in some arrangements for the height of the refrigerator to be no more than 48 inches above the floor. This provides a more ergonomic operation of the microwave oven 2 for the user. In addition, in the stacked position of the components in an exemplary arrangement, the doors 9 and 10 of the microwave 2 and refrigerator 3, respectively, are arranged in a common plane.

At least one power control circuit 4 serves as a controller for the operation of the microwave oven 2 and is also adapted to control the other components of system 1, as shown in FIG. 3. Power is distributed throughout the system 1 under control of microwave controller 4 and digitally operated switches such as relays 19 and 20 represented in FIG. 3. It should be understood that in some arrangements the relays may control power delivery via mechanical contacts while in other embodiments, solid state relays may be used. Power is distributed to each of the appliance components 2 and 3, and to auxiliary low power receptacles 11 and 12. In use lamps 13 and 14 in the form of LEDs or the like may be positioned adjacent to the auxiliary receptacles to indicate power being available from the adjacent receptacle or power to the receptacle being disabled. The low power auxiliary receptacles 11 and 12 are provided to permit convenient access for plugging in a low power device, for example, devices including rechargeable batteries, such as

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cellular phones, PDAs, or other electronic devices that do not demand high power. As shown in the graph of FIG. 8, there are instances during which, if more than one of the appliances is in use, the cumulative current would cause an overload condition.

An exemplary control panel 22 of microwave oven 2 may be adapted to provide a display of the particular status of the controlling relays. For example, LEDs 13 and 14 may indicate that power to the outlets 11 and 12 are disabled or available. In one exemplary arrangement the lamps will light when power is available at the outlet and flash when disabled. In another exemplary arrangement the lamps will light when power is not available at the outlet and not activate when power is available at the outlet as a means to reduce the standby power draw. A button operated touch panel is used in the exemplary arrangement to provide manual control.

As shown in FIG. 4, in order to control the power to the microwave 2, refrigerator 3 and receptacles 11 and 12, sensing circuits, may be coupled to the at least one control circuit to monitor current draw by the appliance components and the auxiliary receptacles. A relay 20 is connected in the power line to the refrigerator and may be actuated by signals from controller 4. In particular, according to an exemplary arrangement, sensing circuits 16, as shown in FIG. 4, have sensors 17 and 18 coupled to the power line of the auxiliary outlets 11 and 12 to monitor the current being drawn by a connected device. Sensors 17 and 18 may include current sensing transformers of the type available from Triad Magnetics of Corona, Calif. The signals generated by sensors 17 and 18 may be used to activate switches or other control components, such as relays 19. Relays 19 may be actuated by the at least one control circuit 4 to enable and disable the delivery of power to the low power auxiliary outlets 11 and 12 in response to signals from sensors 17 and 18. A maximum current may be set through the program logic associated with the at least one power control circuit 4 to prevent overload of the outlets 11 and 12. In one arrangement of the system, the maximum current limit is set at 2 amps, and the control circuitry is operated to cease power delivery in situations where the power draw exceeds this amount. Of course this approach is exemplary.

In another exemplary arrangement, a clock function 21 included in the at least one power control circuit 4 is used to provide timed delays during which, for example, refrigerator 3 would be prevented from undesirably rapid on/off cycles. When the compressor of the refrigerator 3 is disabled during microwave cooking operation, a time delay of 3 minutes is provided during which the compressor of the refrigerator 3 will remain disabled, even if microwave use is only for a short period. Control circuit 4 may be programmed to manage the power delivery to the components of the appliance to avoid overload conditions, while minimizing disruptions in the use of an individual appliance component. A model of operative events and related control operations may be designed into the program instructions executed by at least one control circuit 4 to provide a control methodology as illustrated in FIGS. 5-7.

In one exemplary arrangement, as illustrated in the block diagram of FIG. 3, at least one control circuit 4, constructed as part of the controller for microwave 2, is adapted to receive and process the sensor signals and identify particular events in the system 1 related to a particular appliance component or combination of appliance component conditions. Circuit 4 controls the power to microwave 2 and refrigerator 3 and also low power receptacles 11 and 12 to avoid overload conditions. The circuit 4 is operative to

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execute the control methods illustrated and described below. In one exemplary arrangement, the circuit 4 is operative to control operations of microwave oven 2 and is adapted to execute the program instructions described below. The at least one control circuit is coupled directly to refrigerator outlet 15 and low power outlets 11 and 12.

In one exemplary arrangement, shown in FIG. 1, the outlets 11, and 12, are included as part of the front control panel of microwave oven 2. In FIG. 2, in another arrangement, the auxiliary receptacles 11 and 12 and refrigerator receptacle 15 are accessible at the rear of the microwave oven 2. In these alternative arrangements, the microwave oven 2 is connected by supply cord 8 directly to power supply receptacle 5. Refrigerator 3 is connected by power cord 7 to receptacle 15 on microwave oven 2 as shown in FIG. 2.

In one exemplary arrangement, control models for program logic flows are established as shown in FIGS. 5-7 for execution by the at least one control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware associated with the circuit 4. The models shown are, in the first instance, dependent on the state of operation of microwave oven 2. The current demands of the microwave 2 when drawing cooking power are generally the most significant contribution to overload, as shown in FIG. 8. To avoid overload conditions, power to the low power receptacles 11 and 12 and refrigerator receptacle 15 is disabled during microwave magnetron operation. If the refrigerator 3 compressor is drawing power when the microwave 2 is turned on to commence cooking, the power to the refrigerator compressor is turned off and clock function 21 is used to determine a predetermined period during which the compressor of refrigerator 3 cannot be restarted. A time delay, for example, of 3 minutes, may be set through programming of the at least one control circuit and when this delay period has expired, receptacle 15 may again be enabled, providing the control circuit determines in accordance with its programming and sensed parameters that microwave cooking operation has ceased. This prevents a too rapid restart of the compressor that may otherwise result in damage.

In some exemplary arrangements, the at least one control circuit of the power controller may operate responsive to sensing the power draw of the refrigerator and the cooking element of the microwave oven so as to detect the power draw reaching a threshold which should not be exceeded to prevent an overload condition. In other exemplary arrangements, the control circuitry may operate to detect inputs that may be provided by input devices and which are operative to cause power drawing components of devices such as the magnetron of the microwave oven or the compressor of the refrigerator to operate. In such arrangements, the control circuitry may operate to detect the signal from a thermostat within the refrigerator which indicates that the thermostat is signaling that the refrigerant compressor should operate to cause the temperature to be lowered within the cooling area of the refrigerator. In such arrangements, the at least one control circuit may operate to detect the signal from the thermostat and prevent the delivery of power to the compressor in situations where the cooking element of the microwave oven is operating. In such arrangements the control circuitry may delay the supply of power to the compressor until the cooking element of the microwave oven has ceased operation. Likewise in an exemplary arrangement the at least one control circuit may be operative to detect inputs to at least one input device of the control

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panel of the microwave which are provided by a user to commence microwave operation. In response to the detection of such inputs, the exemplary control circuitry may be operative to first cause a determination to be made as to whether the refrigerator is drawing the level of power that indicates that the compressor thereof is operating. In response to a determination that the refrigerator is drawing a level of power that is incompatible with operation of the microwave cooking element, the exemplary control circuitry may be operative to cause power to the refrigerator compressor to be withdrawn. Thereafter the at least one control circuit may be operative to cause power to be supplied to the cooking element of the microwave. Further in exemplary arrangements, the at least one control circuit may also monitor the power draw of auxiliary outlets or other power delivery points to assure that the level of draw that is currently occurring will not be an impediment to an operation that is being requested by an input device of the apparatus before the apparatus begins to operate in a manner that will cause increased power draw. Thus the exemplary appliance apparatus enables the preventative action of discontinuing operation of a power drawing component before instituting operation of another component that draws a high level of power. Of course it should be understood that this approach is exemplary and in other arrangements, other approaches may be used.

In the arrangement shown in FIG. 5, if low power is demanded at receptacle 11 or 12 and microwave oven 2 is not in use for cooking, power is supplied to the low power receptacles, provided further, that the current demand at an individual outlet does not exceed a preset limit, for example, 2 amps. Since the auxiliary outlets may be enabled during refrigerator compressor operation, there may be an overload generated at peak compressor operation. In one arrangement the at least one control circuit acts to disable the auxiliary outlets during compressor startup to prevent accidental overload of the system. Therefore as illustrated in the logic flow diagram of FIG. 5, control circuitry may be adapted to check the operational status of the refrigerator, as well as the microwave oven, prior to enabling the auxiliary outlets.

FIGS. 9-11 illustrate another exemplary arrangement. In this arrangement the sensing components 117 and 118 are configured to reduce the risk of overload by the combined demands of the auxiliary outlets 111 and 112 and the refrigerator outlet 115. In the exemplary configuration as shown in FIG. 10, current sensor 117 is configured to monitor the current draw through the refrigerator outlet 115 and the circuitry is operative to limit the refrigerator current draw at the outlet 115 so that it does not exceed 10 amps. Current sensor 118 is connected to monitor the combined current in the auxiliary outlets 111 and 112. Current sensor 118 and the control circuitry is configured to limit the combined auxiliary outlet current draw to 4 amps. In this manner the risk of overload is minimized. As represented in the block diagram of FIG. 9, the microwave 102 has at least one control circuit comprising controller 104 that is operatively connected to power supply 105. Clock function 121 which is shown schematically separately but may be part of the controller provides a timing device to determine a restart delay for power to refrigerator 103. Sensing circuit/sensor 117 is configured to monitor the current demanded by refrigerator 103 and sensing circuit/sensor 118 is connected to low power receptacles 111 and 112 is operative to monitor the combined current draw on receptacles 111 and 112. In the exemplary arrangement the control circuitry is shown as operative to control the availability of electrical power to some devices as a whole. For example, if the at least one

control circuit operates to cause power not to be available to the refrigerator, all components of the refrigerator, such as the internal lights, air circulation fan, etc., are not supplied with electrical power, in addition to the compressor, which is the component which is most likely to draw power at a level which may be excessive. However in other arrangements, the at least one control circuit may be configured to deliver and withhold power selectively to individual refrigerator components or groups of such components. Thus in such arrangements the power control circuitry may be operative to withdraw power to the high power draw component(s) such as the compressor, while still making power available to other low power draw components such as the internal fan and/or lights.

Likewise in exemplary arrangements, the power control circuitry is operative to selectively allow power to be available or withdrawn from components of the microwave oven. For example, exemplary arrangements control the availability of power to selected components of the microwave oven such as the magnetron and the auxiliary outlets. The at least one power control circuit of exemplary arrangements may operate to maintain electrical operation of certain components, even though electrical power to other components is not available. For example, an exemplary controller may operate to maintain power to the clock display output on the control panel at all times. Further some exemplary arrangements may assure that power is maintained to control circuitry with programmed settings so that programmed data is not lost. This may include for example programmed data concerning a future time to turn on the cooking function, the power level and/or how long to cook. This way if the memory of the microwave has been programmed to begin to cook a food item placed inside the microwave oven at a future time so it is cooked by the time a person returns (for example) the programmed instructions to carry out those instructions will not be lost. Alternatively, configuration data that enables the microwave oven controller to communicate in a wireless network or with other devices will be preserved even though the control circuitry operates to cause electrical power not to be available to certain components. Of course these are merely examples.

It should be understood that for purposes hereof when it is stated that power is withdrawn or not made available to a microwave oven, refrigerator or other assembly of components, the terminology refers to not making such power available to the entire assembly or to only certain selected components that draw high power such as the refrigerant compressor or magnetron. Likewise herein references to the microwave or the refrigerator operating or running refers to operation of the respective high power draw components such as the magnetron or the compressor, for example.

In an exemplary arrangement, as shown in FIG. 11, a control panel 122 is arranged with at least one input device in the form of a keypad 123 for manual control and a display 124. Auxiliary outlet 111 is shown as accessible from the front and is associated with a status LED indicator and reset button 113 that may be caused to be operative during use and switch to a flashing mode when the microwave is drawing cooking power. Refrigerator outlet 115 is also accessible on the exemplary front panel and is associated with an LED indicator and reset button 114. Similarly LED indicator 114 is controlled to be on by being illuminated during use of the refrigerator and to switch to a flashing mode when the microwave is drawing cooking power. In another exemplary arrangement, the status LED indicator and reset button 113 may be caused to be off during use and switched on or to a flashing mode when the microwave magnetron is drawing

cooking power. Similarly, in this arrangement, the LED indicator 114 is controlled to be off during operation of the refrigerator compressor and switched on or to a flashing mode when the microwave radiation cooking element is operating.

A further exemplary arrangement of the logic flow operational model is shown in FIG. 6. In this model, the refrigerator compressor draws or demands power. This may be triggered by a temperature rise of the refrigerator interior area within the housing of the refrigerator and involve start up of the refrigerator compressor with an associated peak power demand. If the microwave cooking element is sensed by the control circuitry as currently drawing cooking power, the programming of the control circuitry causes power not to be available the refrigerator so that operation of the refrigerator compressor will be delayed. If the microwave cooking element was on and subsequently cycled off, the clock function 21 must be checked by the controller to determine if power availability to the refrigerator to restart can occur. Under some circumstances, it may be necessary to give the refrigerator compressor priority to prevent an undesirable rise in temperature. In the latter instance, the at least one control circuit can be coupled to the refrigerator temperature sensor to execute a programmed sequence during which the microwave cooking element will be disabled by not having power supplied thereto to allow the refrigerator to operate long enough to return to proper operating temperatures.

In the exemplary arrangement of FIG. 7, the exemplary control circuitry operates to give priority to the power demands of the microwave oven, as indicated above. Use of the receptacles 11, 12, and 15 are, therefore, caused to be disabled during microwave cooking operation. The operational models which carry out the logic represented in FIGS. 5-7, may be established by logic flows implemented by instructions that are programmed or imbedded in the control circuitry of controller 4.

In this manner an appliance system of linked components, including a microwave oven, refrigerator, and at least one low power draw device or appliance may all be connected through a common supply cord to a releasably connectable receptacle providing a source of house current or other electrical power level without the risk of inconvenient interruptions or damage during use caused by overloads.

It is also advantageous to provide such a combination microwave/refrigerator system that also provides auxiliary outlets for low power applications, such as for the purpose of recharging batteries in cellular phones, operating lap top computers and other low power devices, while controlling the operation of the appliance to avoid overload conditions.

In another exemplary arrangement as illustrated in FIGS. 12 and 13, the auxiliary outlets or electrical power receptacles 211, 212 may be included as part of the front control panel 222 of the microwave oven 202 and located on the upper portion 270 of the front control panel 222. The auxiliary outlets 211, 212, front control panel 222 and microwave oven 202 are similar to auxiliary outlets 11, 12, front control panel 22, and microwave oven 2 except as discussed below. In this exemplary arrangement, the auxiliary outlets 211, 212 are positioned side by side with respect to each other with each of the auxiliary outlets 211, 212 being at the same height as the other. The auxiliary outlet 211 of FIG. 12 may be associated with a status LED indicator and reset button 213, which is located on the lower portion 272 of the front control panel and in vertical alignment with the auxiliary outlet 211. The status LED indicator and reset button 213 may be caused by the control circuitry of the controller to be on during use and switched to a

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flashing mode to indicate that power is not available therefrom when the microwave oven **202** is drawing cooking power. The auxiliary outlet **212** of FIG. **12** may be associated with status LED and reset button **214**, which is located on the lower portion of the front control panel and in vertical alignment with the auxiliary outlet **212**. The status LED indicator and reset button **214** may be caused by the controller to be on during use and switched to a flashing mode to indicate that power is not available therefrom when the microwave oven **202** is drawing cooking power thereto is withdrawn. In another exemplary arrangement, the status LED indicator and reset button **213** may be caused to be off during the time power is available for use and switched on or to a flashing mode when the microwave oven is running and power thereto is withdrawn. Similarly, in another arrangement, the status LED indicator and reset button **214** may be caused to be off during power availability and switched on or to a flashing mode when the microwave oven is running or the refrigerator is running and the controller causes power not to be available. Other elements and operational features may be similar in structure and function as that of the arrangements shown in FIGS. **1-11**. Thus, the same reference numbers will be used in this exemplary arrangement to indicate elements that are similar in the arrangements shown in FIGS. **1-11**.

Smart technology may be integrated in some of the exemplary arrangements. For example, a user may be able to monitor and/or control the refrigerator **3** such as by turning it on and off remotely by a remote device **217**. The remote device **217** may include a hand held device such as a cellular phone. The cell phone may also be a smart phone. In some exemplary arrangements, the refrigerator, the microwave and/or the controller may include circuitry suitable for communication in a wireless network. Such a wireless network may be established in the facility, residence, office or other location where the combined refrigerator and microwave appliance is operated. Such devices may include circuitry that enables transmission of wireless signals to and from such components. Such communications may include communications of operational properties such as operating status, temperature, programmed values or other information that is pertinent to the operational condition of the particular device. In further exemplary arrangements, circuitry may be operative to enable received wireless messages to modify the operational condition and/or the programming of the particular device.

For example in some exemplary arrangements, the user may be able to communicate from a wireless phone via cellular or WiFi connection to determine that the refrigerator is operating, the temperature therein, the operational status of the compressor or other items. Alternatively and/or in addition, the user may be able to remotely control components of the refrigerator. These may include, for example, the ability to remotely turn on the internal light within the refrigerator and to view the food items currently housed within the refrigerator via one or more electronic cameras positioned therein. This may enable a user, for example, to determine that they need to purchase additional groceries or other items for purposes of an upcoming meal or other activities. Alternatively and/or in addition, in some exemplary arrangements, instructions may be utilized to change the temperature within the refrigerator. This may be done, for example, to chill certain grocery items that may need to be cooled or frozen for certain purposes. Of course these approaches are exemplary.

Likewise the microwave oven may include interface circuitry which enables the remote monitoring of the con-

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dition of the microwave oven components via a remote wireless device. This may include, for example, determining the periods of past operation and current status of the microwave oven such as whether it is currently being used to cook items. Alternatively and/or in addition, the remote monitoring capabilities may include determining the programmed status of the controller of the microwave oven such as the controller being programmed to cook an item housed in the microwave oven at a set future time or for a particular duration at a particular power level. Alternatively and/or in addition, the remote operational capabilities associated with the microwave control circuitry may include the ability to turn on an internal light within the cooking chamber of the microwave oven and to view via a camera whether an item is contained therein. Further such remote capabilities may also include the ability to remotely change the program parameters so as to initiate cooking at a different time or at a different power level. Likewise exemplary arrangements may include having the wireless interface in operative connection with the at least one power control circuit to provide the ability to monitor the current status of power draw on auxiliary outlets, the occurrence of alarm conditions, or the current status of other connected devices. It should be understood that such capabilities may be implemented in the controller circuitry or in separate circuitry of the microwave oven and/or the refrigerator. Further the exemplary arrangements may utilize communications interface capabilities included in circuitry of the controller to facilitate monitoring and operational control of the appliance. Of course these capabilities are exemplary and in other arrangements, other approaches may be used.

In an exemplary arrangement a charging pad **219** (FIG. **14**) may be provided on the microwave oven **2** or other suitable location to receive a smart phone or other chargeable device for purposes of charging the device. For example, a wireless charging pad **219** may be positioned on top **225** of the microwave oven **2** for recharging the smart phone or other device. The charging pad **219** may be built into the top **225** of the microwave oven **2** or may be a separate component that is mounted to the top **225** of the microwave oven **2** or other location. The exemplary charging pad **219** includes an inductive charging pad and includes a recessed area **220** for receiving an item to be charged such as the smart phone. The at least one control circuit may include or be in operative connection with a wireless interface **221** configured for communicating with the remote control device **217** for controlling the microwave oven or refrigerator and work in conjunction with the control circuitry to perform functions such as removing the supply of electrical power to the microwave oven **2** and/or refrigerator **3**. In an exemplary arrangement, USB ports **223**, **224** may be provided in the area of the charging pad **219**. Alternatively, or in addition, power outlets may be provided in proximity to the charging pad **219**. Alternatively, the charging pad **219** may be provided on the front, side, rear or bottom of the microwave oven **2**, or at another suitable location in connection with the combined appliance structure.

The exemplary charging pad **219** may utilize inductive or wireless charging, which uses an electromagnetic field to transfer energy between the charging pad **219** and the device being charged. In general, the charging pad **219** may include a primary inductive coil **402** (FIG. **28**) in connection with circuitry that is operative to create an alternating electromagnetic field that is received by a secondary inductive coil **404** (FIG. **28**) connected to the circuitry of the device being charged such as device **217**. Power from the electromagnetic field is converted back into electric current to charge a

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battery 406 (FIG. 28) in the device. FIG. 28 shows an exemplary arrangement in which the charging pad 219 utilizes inductive charging to charge the device 217. In this arrangement, the charging pad 219 includes an inductive charging station 408 and the primary inductive coil 402. The power source 5 provides electrical power to the inductive charging station 408 and the other components of the charging pad 219.

The inductive charging station 408 is provided for inductively charging the device 217 and may be built into or otherwise attached to the charging pad 219. The inductive charging station 408 may include the primary inductive coil 402 that is connected to the power source 5 for the microwave oven 2. The recessed area 220 may define a cover of the charging pad 219 that covers the primary inductive coil 402 and provide a surface on which the remote device 217 may be placed for charging. The inductive charging station 408 may also include one or more capacitors coupled in series and/or parallel with the primary inductive coil 402 to form an LC circuit. The inductance value of the primary inductive coil 402 and the capacitance value of the capacitor or capacitors may be selected to achieve a desired resonant frequency which corresponds to a frequency of a coil and circuitry in the device being charged, but it should be noted that this exemplary arrangement is not limited to any particular inductance and/or capacitance values and/or any particular power source ratings.

The device 217 or other device to be charged may include the battery 406 that provides electrical power to the components and circuitry of the device. The battery 406 may comprise a rechargeable battery or batteries including lead acid, nickel cadmium (NiCad), nickel metal hydride (NiMH), lithium ion (Li-ion) or lithium ion polymer (Li-ion polymer) batteries. The device may include any number of batteries, the size and rating of which may vary. The battery 406 may also comprise power conduits, connectors, receptacles, battery connectors, or power cables coupled with batteries.

The device 217 or other device to be charged may include an inductive charger 410 for charging the battery 406 when the device 217 is placed on or in the vicinity of the inductive charging station 408 of the charging pad 219. The inductive charger 410 may be built into or otherwise attached to the device to be charged. As schematically represented in FIG. 28, the inductive charger 410 may include the secondary inductive coil 404 and a charging circuit 412 that is connected to the battery 406. The inductance value of the secondary inductive coil 404 may be selected to correspond or complement the inductance value of the primary inductive coil 402, but it should be noted that in exemplary arrangements the secondary inductive coil is not limited to any particular inductance value. Likewise, the power rating of the charging circuit 412 may be selected to match or complement the rating of the battery 406. The two inductive coils 402, 404 in proximity combine to operate in a manner similar to the principles employed in an electrical transformer. Further in some arrangements greater distances between primary and secondary inductive coils and/or more effective charging can be achieved when the inductive charging system uses resonant inductive coupling. Of course the described approaches are exemplary and in other arrangements other approaches may be used. In some exemplary arrangements the charging pad may be in operative connection with the at least one control circuit that controls power availability to components of the device. For example, the control circuitry may operate in accordance with its programmed instructions to cause power to not be

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available to the charging pad when the microwave draws cooking power. Alternatively or in addition the control circuitry may be operative to cause power not to be available to the charging pad responsive to power draw by the refrigerator compressor, the auxiliary outlets or other items, and/or cumulative power draw of multiple items.

As shown in FIGS. 16, 18, and 20, a safety sensor which is alternatively referred to herein as a safety circuit 226 such as a smoke or gas sensor may be provided in connection with the microwave oven 2. The smoke sensor 226 operates in connection with exemplary at least one control circuit to turn off the microwave oven upon sensing smoke or polluted air indicative of a potentially dangerous condition such as excessive smoke generated from overcooked food. The exemplary safety sensor 226 may be powered on or otherwise operational when the microwave oven is in operation. The sensor circuitry may operate responsive to processor executable instructions to determine the optimal activation point. The exemplary smoke sensor may be battery-powered or powered by the house current that powers the combined appliance with an optional battery backup when the power from the house current is out. The smoke sensor may include an ionization smoke sensor that uses a radioisotope, typically Americium-241, to ionize air. The exemplary ionization smoke sensor circuitry operates to turn off power to the magnetron cooking element of the microwave oven upon sensing a difference due to smoke indicative of a potentially dangerous condition. The smoke sensor alternatively may include a radiation type smoke detector that may contain a source emitter of infrared, visible, or ultraviolet light (typically an incandescent light bulb or light-emitting diode), a lens, and a photoelectric or other type of radiation sensing receiver (typically a photodiode) and suitable control circuitry.

An exemplary sensor 226 may include an alcohol sensor that is coupled with a thermistor 228. An exemplary alcohol sensor 226 may operate in a set temperature range, such as from 32 to 104 degrees Fahrenheit. When a set level of heating is sensed by the thermistor 228, the thermistor 228 through suitable control circuitry causes the alcohol sensor 226 to turn on and become operational and check for properties of the gas within the interior area of the microwave.

If the exemplary alcohol sensor 226 is operational due to the sensing of the set level of heating and senses polluted air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor to the controller 104. Upon receiving the shutdown signal, the controller 104 determines that the radiation cooking emitting element of the microwave oven 2 should be shut down and causes the magnetron of the microwave to shut down through the withdrawal of electrical power. If (after the alcohol sensor is caused to be turned on by the thermistor) the alcohol sensor 226 senses air that is not indicative of a dangerous condition such as the air produced by normal cooking of food in the microwave oven 2, the alcohol sensor circuitry will not send a shutdown signal to the controller 104 and the controller allows the microwave cooking activity to continue.

Alternatively or in addition, a fault indicator 230 may be coupled to the control circuitry of the controller 104 or other circuitry to indicate that there is a dangerous condition upon detection by the alcohol sensor 226. For example, the fault indicator 230 may be an audible indicator such as a buzzer that is activated in response to the alcohol sensor 226 sensing polluted air indicative of a dangerous condition. In another example, fault indicator 230 may include the display 124 displaying a fault message such as "E21" in response to

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the alcohol sensor **226** detecting polluted air indicative of a dangerous condition. Alternatively the fault indicator may output one or more signals, such as wireless alarm signals that can be detected by a receiver of an alarm system or through a remove device such as a smart phone.

An exemplary arrangement may include a combination of fault indicators. For example, upon the alcohol sensor **226** sensing air that is indicative of a dangerous condition, a shutdown signal is outputted by the alcohol sensor **226** to the controller **104**. Upon receiving the shutdown signal, the controller **104** determines that the microwave oven **2** should be shut down and causes the radiation emitting cooking element of microwave oven **2** to be shut down. In addition in an exemplary arrangement, a buzzer is activated and the display **124** displays a fault message such as “E-1” in response to the alcohol sensor **226** sensing polluted air indicative of a dangerous condition.

The alcohol sensor **226** may be reset automatically responsive to the alcohol sensor **226** no longer detecting gas indicative of the dangerous condition. Alternatively or in addition, the alcohol sensor **226** may be reset upon sensing by a suitable switch, opening of the microwave door **9** of the microwave oven **2**. The display may display a “bar” or other suitable icon to indicate that the alcohol sensor **226** is turned on. Other types of suitable safety sensors may also be used instead of the alcohol sensor to detect a dangerous condition within the cooking area of the microwave.

In addition to one or more sensors which detect the gases generated from cooked food, the sensor **226** may include a temperature sensing capability such as, for example, using the thermistor **228** and related elements mentioned above.

Referring to FIG. **24**, in another exemplary arrangement, the safety sensor which is alternatively referred to as a safety circuit may comprise an infrared sensor **326**. The infrared sensor **326** may include two oppositely positioned infra-red disposed infrared sensor elements in the form of a sensor emitter **328** and sensor receiver **330** (schematically shown in FIG. **24**) provided on the microwave oven and located in the microwave’s cavity **332**. The exemplary infrared sensor **326** operates as follows. The sensor emitter **328** emits radiation and the sensor receiver **330** senses sensor radiation from the sensor emitter **328** while the microwave element operates during a cooking session. When smoke that is indicative of a dangerous condition passes in between the infrared sensor elements **328**, **330**, a determination is made by the safety circuit that a transmission amount of sensor radiation from the sensor emitter reaching the sensor receiver has fallen by at least a programmed threshold amount during the cooking session, due to smoke in the cooking interior area. Responsive to the determination, the cooking element of the microwave oven is caused by the safety circuit to be no longer supplied with electrical power. The exemplary safety circuit may use the smoke point of oil or similar food products as the basis for its threshold amount, so that normal smoke emitted during the cooking or heating of food or beverages will not cause the infrared sensor **326** to deactivate cooking operation. The exemplary infrared sensor **326** would not require interaction from the microwave user. The exemplary safety sensor may be operative to cause an initial transmissivity level of sensor radiation that reaches the sensor receiver from the sensor emitter early in the cooking session to be stored in a data store or other memory associated with the safety circuit. The determination of a level of smoke corresponding to a dangerous condition is made in this embodiment responsive to circuitry operating in accordance with programmed instructions to detect that the transmission amount of sensor radiation reaching the sensor receiver has

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dropped by the threshold amount from the initial transmissivity level during the cooking session.

Referring to FIG. **25**, in another exemplary arrangement, the safety sensor or safety circuit may comprise a light sensor **334**, which detects the increase smoke density within the microwave’s cooking area which is alternatively referred to as a cavity. The light sensor **334** may also include a sensor emitter and sensor receiver. The light sensor **334** may be provided in the microwave cavity **332** and may operate as follows. At the beginning of a cooking cycle, the light generated travels through the clean air to the light sensor **334**. As smoke increases in density, the amount of light that reaches the sensor receiver is reduced. The circuitry of light sensor **334** includes a programmed trip point or threshold that corresponds to the reduced amount of light sensed caused by the amount of smoke, that is indicative of a dangerous condition. When the trip point is reached, the safety circuit causes the electrical power to the radiation emitting cooking element to be withdrawn. A circuit determination would be made based on the amount of smoke that corresponds to the trip point and its corresponding light sensor reading.

Referring to FIG. **26**, in another exemplary arrangement, the safety sensor may include an optical motion sensor **336**. The optical motion sensor **336** may also include a sensor emitter and sensor receiver. The optical motion sensor **336** may be positioned in the microwave cavity **332** adjacent air exhaust vents **338**, **340** of the microwave, which comprises an air passage that connects an area where food is cooked in the microwave oven to the air outside the housing of the microwave oven. The optical motion sensor **336** detects motion which is sensed due to the presence of smoke blown by an exhaust fan **342** of the microwave oven **2** through the air passage. The exhaust fan **342** is operative to cause air to move in the air passage connected to the microwave cavity. In an exemplary arrangement, the sensor emitter and sensor receiver are positioned to be operative to sense the transmission of radiation between the emitter and the receiver in the air passage. The optical motion sensor **336** has a trip point or threshold that corresponds to the presence of smoke of a predetermined density that corresponds to a reduced level of transmission that is indicative of a dangerous condition. When the trip point is reached, the optical motion sensor in combination with the control circuitry causes the cooking element of the microwave oven to be turned off. It should be noted that the exemplary optical motion sensor is not be positioned within the microwave cavity and directed toward a turntable therein, since the turntable itself may result in false alarms in some configurations. Of course it should be understood that other types of smoke sensors may be positioned in air passages in other alternative arrangements.

Alternative arrangements may include other types of smoke sensors. For example, some arrangements may include sensors that are operative to detect smoke by determining the level of volatile organic compounds (VOCs) in the air in the microwave oven cooking area. In some exemplary arrangements such VOC sensors may be positioned to sense air in at least a portion of the microwave cooking area. In some cases such VOC sensors may be positioned in an air passage that extends between the microwave cooking area and the air in the atmosphere outside the microwave. Such an arrangement may have an advantage in that positioning the sensor in the air passage may minimize the amount of cooking splatter and other contamination from the food cooked in the microwave oven that reaches the sensor.

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Some exemplary arrangements may include a VOC sensor that comprises a tin dioxide semiconductor gas sensor. In some arrangements the semiconductor is formed on an alumina substrate with a thick film heater of ruthenium oxide on the reverse side. Of course this configuration is exemplary and in other arrangements other configurations and VOC sensor types may be used.

In exemplary microwave oven arrangements VOC sensors may be operated in conjunction with at least one suitable control circuit to detect conditions which correspond to a dangerous smoke condition. Such a dangerous smoke condition is determined responsive to the level of VOCs, such as carbon dioxide and/or carbon monoxide in the air in the cooking area of the microwave oven. Such compounds may generally indicate the presence of combustion which is corresponds to a potentially dangerous condition. Responsive to detecting a threshold VOC concentration in the air of the cooking area, the control circuitry in operative connection with the sensor is operative to cause power to be withdrawn from the magnetron of the microwave oven so as to prematurely end a current cooking session before the set and time thereof. In exemplary arrangements, the sensitivity of the VOC sensors is sufficient to detect a developing potentially dangerous condition and cause power to be withdrawn from the microwave cooking element before a fire or other condition causes damage to the microwave oven. This enables the sensor circuitry to reset when the dangerous smoke condition is no longer detected and enable the microwave oven to operate in a subsequent cooking session.

In some exemplary arrangements multiple sensors in operative connection with detection circuitry is utilized to determine the activation point for an alarm condition based on detection of parameters such as humidity, temperature, temperature rate of change, and gas constituents generated during cooking phases. Combinations of absolute and relative values and rates of change thereof may be detected for purposes of evaluating possible alarm conditions. Other types of sensors that may be used in exemplary arrangements include flame sensors. Flame sensors are operative, detect and provide signals indicative of the presence of a flame or fire. Upon the flame sensor detecting the presence of a flame, the flame sensor causes at least one control circuit to discontinue electrical power to the microwave oven cooking element. In some arrangements the flame sensor may take the form of an optical flame sensor. The flame sensor may be of the type that utilizes ionization current flame detection. Alternatively, the flame sensor may be of the type that utilizes thermocouple flame detection.

Alternatively or in addition, the fault indicator **230** may be coupled to the controller **104** or other circuitry to indicate that there is a dangerous condition upon detection of a potentially dangerous condition by any of the infrared sensor **326**, light sensor **334**, optical motion sensor **336**, or flame or fire sensor in the arrangements described above. For example, the fault indicator **230** may be an audible indicator such as a buzzer that is activated in response to the safety sensor **226** sensing polluted air indicative of a dangerous condition. In another example, fault indicator **230** may include the display **124** displaying a fault message such as "E-1" in response to the safety sensor **226** detecting polluted air indicative of a dangerous condition.

Exemplary arrangements may include a combination of fault indicators. For example, upon the trip point or threshold value being reached by any of the detection circuitry of the infrared sensor **326**, light sensor **334**, or optical motion sensor **336**, a shutdown signal is outputted by the sensor **226**

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to the controller circuitry **104**. Upon receiving the shutdown signal, the controller **104** determines that the microwave oven **2** should be shut down and causes electricity to be withdrawn from the cooking element. In addition, a buzzer is activated and the display **124** displays a fault message such as "E-1" in response to the sensor **226** sensing polluted air indicative of a dangerous condition. In other exemplary arrangements, the controller or other circuitry may be operative to output signals that can be communicated to a remote location, indicative of an alarm condition that is detected through one or more detection circuits of the microwave oven or other connected devices. This may include, for example, the circuitry dispatching messages to a remote device such as a smart phone of a user. The messages caused to be dispatched responsive to operation of the control circuitry may be indicative of an alarm condition that can be output on the display of the user's device to advise that a potentially dangerous condition exists. Alternatively and/or in addition, the control circuitry may be operative to communicate messages to a central controller or alarm panel located in the facility or institution in which the microwave is operated. For example the circuitry may be operative to provide wireless communication to an alarm panel or central monitoring station which receives the information that there is a potentially dangerous condition at the microwave device located in a particular location, dormitory room or other identified area of the building or facility. In still other exemplary arrangements, messages corresponding to alarm conditions that are cause to be sent by the control circuitry of exemplary arrangements may be dispatched to devices or alarm monitoring stations of a security force for an oversight authority within the area in which the microwave is operated. Of course it should be understood that these approaches are exemplary and in other arrangements, other approaches may be used.

Exemplary arrangements may also include the features described in U.S. patent application Ser. No. 15/239,378 filed Aug. 17, 2016 which is published as US Patent Publications 2017-0059233 the disclosure of which is incorporated herein by reference in its entirety. In some exemplary arrangements an appliance like that shown in the incorporated disclosure may include a safe which is suitable for holding valuables or a user's rechargeable devices such as a smart phone. In some exemplary arrangements the safe may include a smoke sensor, heat sensor, flame sensor or other type sensor that is operative to detect a fire or other dangerous condition within the interior area of the safe. Further in exemplary arrangements the at least one control circuit or other circuitry may be operative to dispatch messages to a user's smart phone or other remote computer device to indicate such a fire or other dangerous condition within the interior area of the safe. In addition in exemplary arrangements the at least one control circuit or safe circuitry as described in the incorporated disclosure, may operate an audible alarm to give at least one audible signal of the dangerous condition. Also in exemplary arrangements messages may be dispatched to alarm monitoring stations associated with the building or institution in which the appliance is located. Further in exemplary arrangements a remote notification to a user's mobile device or other computer and/or to an alarm monitoring station may also be given in circumstances in which at least one tamper sensor of one of the types of the incorporated disclosure is operative to sense a safe tamper condition. In such circumstances the at least one safe circuit or other circuitry may be operative to cause a remote notification of the tamper condition to be given and/or an audible signal to be output from an audible alarm.

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Further in exemplary arrangements one or more cameras may be in operative connection with the control circuitry to provide to the user's mobile device or other remote computer and/or to an alarm monitoring station, images associated with the detected condition. These may include images captured by cameras with a field of view outside the safe or the microwave oven or refrigerator of the combined appliance. Alternatively or additionally in other arrangements cameras may be positioned to capture images of an interior area of the safe. In some arrangements this may include a camera that is operative to have a field of view directed at or through the safe opening so that in the event that the safe is opened by an unauthorized person, images of the individual who is responsible for breaking into the safe may be captured. Further in exemplary arrangements the signals may be provided by the safe circuitry which can operate on a battery if the safe is disconnected from the combined appliance and no longer receives power from the at least one power control circuit thereof. Further the safe circuit may also provide GPS or other position signals so that the location of the safe can be tracked. Of course it should be understood that these approaches are exemplary and other arrangements other approaches may be used.

The exemplary detection circuitry of the smoke sensor, infrared sensor 326, light sensor 334, or optical motion sensor 336, may be reset automatically upon the sensor not detecting gas or other conditions that are no longer indicative of the dangerous condition. Alternatively or in addition, the sensor may be reset upon circuitry sensing opening of the microwave door 9 of the microwave oven 2. The display may display a "bar" or other suitable icon to indicate that the sensor is turned on. Other types of suitable safety sensors and circuitry may also be used to detect dangerous conditions. Further in other exemplary arrangements, other circuitry may be in operative connection with the combined appliance or separate components so as to address dangerous conditions. Such items may include, for example, a suitable fire extinguishing system that may be automatically triggered in response to detecting conditions corresponding to fire or smoke within the cooking chamber of the microwave oven. For example in some exemplary arrangements, a compressed supply of carbon dioxide may be included with or be positioned adjacent to the combined appliance. A suitable gas conduit and control valve may be positioned to deliver the carbon dioxide into the cooking chamber of the microwave oven responsive to the detection of flame, excessive temperature or smoke within the microwave cooking chamber. Suitable circuitry in operative connection with the controller or circuitry of the temperature, smoke or flame detection devices may operate to cause the control valve for the delivery of the carbon dioxide or other fire extinguishing material to be opened to cause the delivery thereof responsive at least in part to the detection of one or more of the alarm conditions. Further as can be appreciated, in some exemplary arrangements, the control circuitry may operate in accordance with its programmed instructions to require that the alarm condition be detected as existing for a programmed period of time before the control circuitry operates to cause the fire extinguishing material to be delivered into the cooking chamber. Further although exemplary arrangements may include carbon dioxide as the fire extinguishing material, in other embodiments other types of fire extinguishing or fire suppressing materials may be utilized. These may include, for example, chemical fire extinguishing or retarding materials in the form of powders or foams. Alternatively, and/or in addition, fire suppressing materials may include the delivery of nonflammable gaseous

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material. Of course these approaches are exemplary and in other embodiments, other approaches may be used.

As shown in FIGS. 15, 16 and 27, the exemplary front control panel 22 of the microwave oven 2 may include Universal Serial Bus (USB) ports 232, 234 for connection, communication, and power supply between the front control panel 22 and electronic devices such as a personal computer, cell phone, Smart Phone, iPod®, iPad®, or other suitable device to allow communication and/or charging of the electronic device plugged into the USB ports. In one exemplary arrangement, a first USB port 232 may be provided on the upper portion 236 of the front control panel 22, and a second USB port 234 may be provided on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112 and between the reset buttons 113, 114 as seen in FIG. 15. The first USB port 232 may be operatively connected to a three ampere fuse and a linear time-variant system (LVT) of 100 mA, 120 volts, and 12 watts. The second USB port 234 may be operatively connected to a linear time-variant system (LVT) of 200 mA, 120 volts, and 24 watts. The second USB port 234 may also be reset. The current sensor 118 may be constructed to limit the second USB port and the two auxiliary outlets to 12 amps. The USB ports 232, 234 may be in operative connection with respective printed circuit boards. Alternatively, as represented in FIG. 27, instead of auxiliary outlet 111, another USB port 237 may be provided on the front panel 22 at the location of the auxiliary outlet 111. Alternatively or in addition, one or more USB ports may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively or in addition, one or more auxiliary outlets may be provided on the rear of the microwave oven, the sides of the microwave oven, and/or the top or bottom of the microwave oven. Alternatively, the refrigerator outlet may be provided on the top, bottom, or one of the sides of the microwave oven.

FIGS. 17 and 18 show another exemplary arrangement of a control panel and control circuitry that includes USB ports 232, 234. In this arrangement, the first and second USB ports 232, 234 are located side by side on the lower portion 238 of the front control panel 22 above the auxiliary outlets 111, 112. The USB ports 232, 234 are also located rightwardly (as viewed in FIG. 17) adjacent a status LED indicator and reset button 240. In this exemplary arrangement, current sensor 218 is configured to monitor the combined current in the USB ports 232, 234 and the auxiliary outlets 111 and 112. The current sensor 218 is constructed to limit the combined current in the USB ports and auxiliary outlets 111 and 112, to 12 amperes. The LED indicator and reset button 240 may be controlled to illuminate when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and flash when disabled. In another arrangement, the LED indicator and reset button 240 may be controlled to be off when power to the auxiliary outlets 111, 112 and the USB ports 232, 234 is available and light on illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables power delivery from the auxiliary outlets 111, 112 and the USB ports 232, 234 so that power may be again supplied from them after a power interruption due to excessive power draw, when the combined current draw falls from above to below the limit. Of course it should also be understood that in exemplary arrangements, the controller or other control circuitry that operates to avoid excessive power draw may also operate to discontinue delivery of power from the receptacles and the USB ports in circumstances where the power draw of the microwave cooking element and/or the refrigerator com-

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pressor requires the power delivery from the auxiliary outlets and USB ports be discontinued. In such exemplary arrangements, the control circuitry may operate to automatically resume the delivery of power to such receptacles and ports or in other embodiments a manual input may be required to cause the delivery of power to be reinstituted. Of course it should be understood that these approaches are exemplary and in other arrangements other approaches may be used.

FIGS. 19 and 20 show an alternative arrangement in which one USB port 234 is located above the auxiliary outlets 111, 112 and rightwardly adjacent the status LED indicator and reset button 240. In this exemplary arrangement, the current sensor 218 is configured to monitor the combined current draw from the USB port 234 and auxiliary outlets 111 and 112. The current sensor 218 is configured to limit the combined current draw from the USB port 234 and auxiliary outlets 111 and 112, to 12 amperes. Alternatively, the current sensor 218 may be configured to limit the combined current in the USB port 234 and the auxiliary outlets 111 and 112 to 13 amperes. The LED indicator and reset button 240 may be controlled to illuminate when power to the auxiliary outlets 111, 112 and the USB port 234 is available, and flash when the control circuitry causes the outlets and ports to be disabled. In another exemplary arrangement, the LED indicator and reset button 240 may be off when power to the auxiliary outlets 111, 112 and the USB port 234 is available, and illuminate or flash when disabled. In an exemplary arrangement, depressing the LED indicator and reset button 240 enables operation of the auxiliary outlets 111, 112 and the USB port 234 so that power may be again supplied from them after the controller discontinues the supply of power thereto when the combined current draw falls from above to below the limit. Of course as is the case with the previously described arrangement, the controller and other circuitry may be operative to also discontinue the supply of electrical power to the auxiliary receptacles and/or USB ports when power draw is required for the magnetron of the microwave or the refrigerator compressor is sensed that power delivery to other devices needs to be discontinued to limit excessive power draw. In such circumstances, the discontinuance of power to the auxiliary receptacles and USB ports may be automatically reinstated responsive to operation of the controller. Alternatively, in other arrangements, manual inputs may be required from a user to reinstitute the electrical delivery therefrom. Further in some exemplary arrangements, the controller may be configured so as to require manual inputs to reinstate electrical delivery only under circumstances where excessive power draw above the limits from the one or more auxiliary outlets or USB ports has occurred, thus requiring a manual input to reinstitute the electrical power delivery therefrom. Of course these approaches are exemplary and in other arrangements other approaches may be used. Other elements of the arrangements of FIGS. 17-20 may be similar in structure and function as the arrangements shown in FIGS. 1-11. Thus, the same reference numbers are used in describing these exemplary arrangements to indicate elements that are similar to elements or components in the arrangements shown in FIGS. 1-11.

FIG. 21 shows the rear portion 244 of the exemplary microwave oven of the arrangements shown in FIGS. 12-20. Refrigerator outlet 15 is shown on and accessible from the rear portion 244 of the microwave oven and is associated with the LED indicator and reset button 214, which is also provided on the rear portion 244 of the microwave oven.

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FIG. 22 is a similar view as FIG. 21 except that an AC electrical cord 8 for the microwave oven is shown.

In the arrangements shown in FIGS. 12-22, control models for control logic may be established for execution of executable instructions by the controller or microprocessor which is also referred to herein as at least one electrical power control circuit 4. These models can be in the form of processor executable instructions stored in a computer readable medium, such as software or firmware within the control circuit 104. The exemplary models and logic flow are, in the first instance, dependent on the state of operation of the microwave oven 2. The current demands of the microwave oven 2 are generally the most significant contribution to overload. To avoid overload conditions, in exemplary arrangements power to the low power receptacles or auxiliary outlets, refrigerator receptacle, and/or USB ports is disabled during microwave operation.

FIG. 23 shows a flow chart illustrating several control models for operational scenarios. The at least one power control circuit 104 begins by determining whether the microwave oven is turned on or operating (e.g. cooking) in step 246. When the microwave oven is turned on and operating to perform cooking, the rear refrigerator outlet 15, the two auxiliary outlets 111, 112 on the front control panel 22, and the two USB ports 232, 234 on the front control panel are all turned off or disabled, so that the total draw of current for the combination microwave and refrigerator is not over 15 amperes as indicated in step 248.

When the microwave oven is not drawing cooking power and items are plugged into the two USB ports 232, 234, two auxiliary outlets 111, 112, and rear refrigerator outlet 15, then the exemplary at least one control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 2 amperes (approximately the average amperes when the refrigerator compressor is running) in step 250. If the refrigerator outlet 15 is drawing less than 2 amperes, then all the outlets 15, 111, 112 and USB ports 232, 234 are caused to be enabled, so that power may be supplied through them as indicated in step 252. If the refrigerator outlet 15 not drawing less than 2 amperes, the at least one control circuit 104 determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 254. If the refrigerator outlet 15 is drawing less than 14 amperes but not less than or greater than or equal to 2 amperes, then the auxiliary outlets 111, 112 and USB ports 232, 234 are disabled or turned off so that no power may be supplied from them as indicated in step 256. The refrigerator outlet 15 remains enabled. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 is disabled in step 258. This may be accomplished by tripping the relay 20 of the reset circuit off. In addition, the red LED light on the LED indicator and reset button 214 is turned on to identify the disabled condition of the refrigerator. Then, in step 260, the auxiliary outlets 111, 112 and USB ports 232, 234 are enabled so that power may be supplied through them.

Then, the exemplary at least one control circuit determines whether the refrigerator outlet 15 is drawing less than 14 amperes in step 262. If the refrigerator outlet 15 is not drawing less than 14 amperes or drawing greater than or equal to 14 amperes, then the refrigerator outlet 15 remains disabled and the red LED light on the LED indicator and reset button 214 remains turned on to identify the disabled condition of the refrigerator 3. This condition may occur, for example, if an electrical heater is plugged into what is normally used as the refrigerator electrical supply outlet 15. When the refrigerator outlet 15 draws less than 14 amperes

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resulting from the overload condition being eliminated, the refrigerator outlet 15 will be enabled by the control circuit so that power may be supplied to the refrigerator outlet 15 upon the LED indicator and reset button 214 being depressed as indicated in step 264. Depression of the LED indicator and reset button 214 in this condition will also turn off the red LED light. The process then ends. It should be noted that the at least one control circuit 104 can make the determination in steps at the same time or in a different order.

It should be understood that in exemplary arrangements, determination as to the power draw from receptacles that have been disabled, may be determined through a process of again supplying power output through the receptacle. The power draw from the receptacle is monitored continuously after the power is restored and if it is detected that the power draw exceeds a threshold or other determined amount, power is discontinued to the receptacle. In some exemplary arrangements, the power sensing circuitry may operate in conjunction with the controller to calculate the current power draw level. The control circuitry may also operate in accordance with its programming to determine that other connected devices are consuming power which may necessitate not providing power to the receptacle so as to avoid an overload condition. Alternatively or in addition, the control circuitry may be operative to monitor other conditions that may be indicative of a problem when the power is restored to a receptacle, port or other control outlet. For example, responsive to a manual input to reinstitute the supply of power thereto, the control circuitry may operate to recognize conditions that correspond to an electrical short or other malfunction which necessitates an immediate withdrawal of electrical power thereto. This may include, for example, monitoring the rate at which power is drawn and the current flow increases to detect a short or other fault condition. Numerous different types of detection circuitry and control approaches may be implemented in order to help assure that if power output has been discontinued, that excessive power draw or undesirable conditions are not a problem when power is reinstated.

Although exemplary arrangements are described herein as used in conjunction with vapor compression refrigerators, embodiments employing the principles described herein may also be used with other types of refrigerators. Such refrigerators may include refrigerators that use thermoelectric cooling, such as Peltier elements to provide cooling. Other arrangements may include absorption refrigerators to provide cooling. In such arrangements the components of the refrigerator apparatus which draw electrical power, are controlled through operation of at least one power control circuit, to prevent, suspend or defer the operation thereof at times when the microwave radiation emitting cooking element of other components that draw electrical power are to be operated, so as to avoid exceeding a maximum threshold for current draw for the combined appliance that is permitted by the at least one control circuit.

It should be understood that the above description is only illustrative of the exemplary arrangements. Various alternatives and modifications can be devised by those skilled in the art without departing from the teachings of exemplary arrangements. Accordingly, the present application is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

Thus the exemplary systems, arrangements, and methods of operation that have been described herein achieve desirable capabilities, eliminate difficulties encountered in the use of prior devices and systems and attain the useful results described herein.

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In the foregoing description, certain terms have been used in describing exemplary arrangements for purposes of brevity, clarity and understanding. However, no unnecessary limitations are to be implied therefrom because such terms are used for descriptive purposes and are intended to be broadly construed. Moreover, the descriptions and illustrations herein are by way of examples and the inventive features are not limited to the particular features shown and described.

Further it should be understood that elements, features, relationships, devices and other aspects described in connection with one exemplary arrangement may be utilized in connection with other exemplary arrangements such that numerous different arrangements, functions and capabilities may be carried out. Numerous different aspects of described arrangements may be used together or in different combinations to achieve useful results.

Having described the features, discoveries and principles of the exemplary arrangements, the manner in which they are constructed and operated, and the advantages and useful results attained, the new and useful structures, devices, elements, arrangements, parts, combinations, systems, equipment, operations, methods, processes and relationships are set forth in the appended claims.

We claim:

1. Apparatus comprising:

a microwave oven, wherein the microwave oven includes a magnetron, wherein the magnetron is configured to cook items in a cooking area within the microwave oven,

a smoke sensor, wherein the smoke sensor is positioned in operative connection with the cooking area,

a power cord, wherein the power cord is configured to be releasably connected to a source of electrical power,

at least one externally accessible electrical connector, wherein each electrical connector is configured to deliver electrical power that is received through the power cord through the respective electrical connector to a respective electrically powered device that is outside of the microwave oven,

at least one power control circuit, wherein the at least one power control circuit is in operative electrical connection with each of the power cord, the at least one electrical connector, the magnetron, and the smoke sensor,

wherein responsive at least in part to a level of smoke sensed by the smoke sensor, the at least one power control circuit is operative to cause cooking power to the magnetron to be withdrawn to end a current cooking session prior to a set end time of the current cooking session,

wherein after the current cooking session has been caused to end prior to the set end time based on the sensed level of smoke, the at least one power control circuit is operative thereafter to enable the magnetron to receive cooking power in a next subsequent cooking session.

2. The apparatus according to claim 1

wherein the at least one power control circuit is operative to cause electrical power to be unavailable to the at least one electrical connector during at least a portion of the time that the magnetron is operative.

3. The apparatus according to claim 1

wherein the at least one electrical connector comprises an electric outlet configured to releasably receive a plug in electrical connection therewith,

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wherein the at least one power control circuit is operative to cause electrical power to be unavailable to the electric outlet during at least a portion of the time that the magnetron is operative.

4. The apparatus according to claim 1 5
 wherein the at least one electrical connector includes a USB port,
 wherein the at least one power control circuit is operative to cause electrical power to be unavailable to the USB port during at least a portion of the time that the magnetron is operative. 10

5. The apparatus according to claim 1
 wherein the smoke sensor includes at least one of
 a radiation emitter and radiation receiver, 15
 a photosensor,
 a motion sensor,
 an ionization sensor, and
 a VOC sensor.

6. The apparatus according to claim 1 20
 wherein the at least one electrical connector comprises an electric outlet configured to releasably receive a plug of a refrigerator in electrical connection therewith,
 wherein the at least one power control circuit is operative to cause electrical power to be unavailable to the electric outlet during at least a portion of the time that the magnetron is operative. 25

7. The apparatus according to claim 1
 wherein the power cord comprises a single power cord,
 wherein the at least one electrical connector includes 30
 an electric outlet, and
 a USB port.

8. The apparatus according to claim 1
 wherein the power cord comprises a single power cord,
 wherein the at least one electrical connector includes at 35
 least one of
 an electric outlet, and
 a USB port,
 wherein the at least one power control circuit is operative to cause electrical power to be unavailable to at least one of the electric outlet and the USB port during at least a portion of the time that the magnetron is operative. 40

9. The apparatus according to claim 1
 wherein the at least one power control circuit is operative to cause electrical power to be unavailable to the at least one electrical connector during at least a portion of the time that the magnetron is operative, and for a predetermined time period after electrical power becomes unavailable to the at least one electrical connector. 50

10. The apparatus according to claim 1
 wherein the at least one power control circuit is operative to cause cooking power to the magnetron to be withdrawn to end the cooking session responsive at least in part to sensing the level of smoke continuously for a predetermined time. 55

11. The apparatus according to claim 1
 wherein the microwave oven includes a front side and a back side, 60
 wherein the front side includes a control panel, an opening and a movable door, wherein in an open position of the door, the cooking area is accessible from outside the microwave oven,
 wherein the power cord comprises a single power cord, 65
 wherein the at least one electrical connector includes an electric outlet on the back side.

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12. The apparatus according to claim 1
 wherein the microwave oven includes a front side in a back side,
 wherein the front side includes a control panel, an opening and a movable door, wherein in an open position of the door the cooking area is accessible from outside the microwave oven,
 wherein the power cord comprises a single power cord,
 wherein the at least one electrical connector includes an electric outlet on the back side, and
 a USB port on the front side,
 wherein the at least one power control circuit is operative to cause electrical power to be unavailable to at least one the electric outlet and the USB port during at least a portion of the time that the magnetron is operative.

13. The apparatus according to claim 1
 and further comprising:
 a refrigerator, wherein the refrigerator is electrically connected to the at least one externally accessible electrical connector,
 wherein the at least one power control circuit is operative to cause electrical power to be unavailable to the refrigerator during at least a portion of the time that the magnetron is operative.

14. The apparatus according to claim 1
 wherein the at least one power control circuit is operative to cause electrical power to be unavailable to the at least one electrical connector while the magnetron is operative and for at least a preset minimum period after the magnetron becomes inoperative.

15. Apparatus comprising:
 a microwave oven, wherein the microwave oven includes a cooking area within the microwave oven,
 a magnetron, wherein the magnetron is configured to cook items in the cooking area,
 at least one smoke sensor, wherein the smoke sensor is positioned in operative connection with the cooking area,
 at least one externally accessible electrical connector, wherein each electrical connector is configured to deliver electrical power from the microwave oven,
 at least one power control circuit, wherein the at least one power control circuit is in operative electrical connection with the magnetron, the at least one smoke sensor, and the at least one electrical connector,
 wherein responsive at least in part to a level of smoke sensed by the at least one smoke sensor during a cooking session, the at least one power control circuit is operative to cause power to the magnetron to be withdrawn to end the cooking session prior to a set end time,
 wherein after the cooking session has been caused the end based on the sensed level of smoke, the at least one power control circuit is operative thereafter to enable the magnetron to receive power to commence a next subsequent cooking session.

16. The apparatus according to claim 15
 wherein the at least one power control circuit is operative to cause power to be unavailable from the at least one electrical connector when cooking power is delivered to the magnetron.

17. The apparatus according to claim 15
 wherein the at least one electrical connector comprises an electric outlet configured to deliver household current and to releasably receive a plug in electrical connection therewith.

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18. The apparatus according to claim 15
wherein the at least one electrical connector comprises a
USB port.
19. The apparatus according to claim 15
wherein the at least one electrical connector comprises 5
an electric outlet configured to deliver household cur-
rent, and a USB port,
wherein the at least one power control circuit is operative
to cause electrical power to not be deliverable from
each of the electric socket and the USB port when 10
cooking power is delivered to the magnetron.
20. The apparatus according to claim 15
and further comprising:
at least one of
a refrigerator, and 15
a safe,
wherein the at least one of the refrigerator and the safe
is in operative electrical connection with the at least
one power control circuit.
21. The apparatus according to claim 15
wherein the electrical connector includes an electric outlet 20
configured to receive a plug that is in electrical con-
nection with a refrigerator,
wherein the at least one power control circuit is operative
to cause electrical power to be unavailable from the 25
electric outlet while cooking power is delivered to the
magnetron and for a period of time thereafter.
22. Apparatus comprising:
a microwave oven, wherein the microwave oven includes
a cooking area within the microwave oven,
a magnetron, wherein the magnetron is configured to 30
cook items positioned in the cooking area,
at least one smoke sensor, wherein the at least one
smoke sensor is positioned in operative connection
with the cooking area,
at least one power control circuit, wherein the at least 35
one power control circuit is in operative connection
with each of the magnetron and the at least one
smoke sensor,

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- wherein the at least one power control circuit is opera-
tive to cause
responsive at least in part to a level of smoke sensed
by the at least one smoke sensor, cooking power
being currently delivered to the magnetron to be
withdrawn whereby a current cooking session is
ended prior to a set end time, and
after the current cooking session has been caused to
end prior to the set end time based on the sensed
level of smoke, cooking power to be delivered to
the magnetron to commence a next subsequent
cooking session.
23. The apparatus according to claim 22
wherein the microwave oven further comprises
at least one externally accessible electrical connector,
wherein each electrical connector is configured to
deliver electrical power from the microwave oven
through the respective electrical connector,
wherein the at least one electrical connector is in
operative connection with the at least one power
control circuit,
wherein the at least one power control circuit is opera-
tive to cause electrical power to be unavailable from
the at least one electrical connector when cooking
power is being delivered to the magnetron.
24. The apparatus according to claim 22
wherein the microwave oven further includes
at least one externally accessible electrical outlet,
wherein the electrical outlet is in operative connection
with the at least one power control circuit,
wherein the at least one power control circuit is opera-
tive to cause electrical power to be unavailable from the
electrical outlet when cooking power is being delivered
to the magnetron and for a period of time after cooking
power is no longer delivered to the magnetron.

* * * * *

EXHIBIT 7

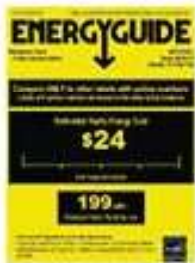
MicroChill



Smart Stop - Internal Smoke Sensor



Reduce hall evacuations and calls to the fire department with our Internal Smoke Sensor.



Cabinet Features
Black Textured Finish
Low Profile Recessed Handles
Reversible Door Hinges
5'6" Power Cord



199 kWh
HIGHEST EFFICIENCY AVAILABLE

Dual USB PORT



Free up outlets and charge your phones, blue-tooth speakers and many other devices with our Dual USB Ports.

-Interior Dimensions-
Oven Capacity: 0.8 cu. ft.

-Interior Volume-
3.2 cu. ft
Fridge Volume: 2.3 cu. ft.
Freezer Volume: .90 cu. ft.

Exterior Dimensions
Height: 44 5/8"
Width: 18 9/16"
Width with door open 180°: 34 3/4"
Depth: 19 3/8"
Depth with door open 90°: 35 1/4"

712-226-3250

www.collegeproducts.com

sales@collegeproducts.com

-MICROWAVE FEATURES-

Dual USB Charging Station
2 - 2.0 Amp Ports
Internal Smoke Sensor
Electronic Control Panel
One Touch Cooking Programs
Kitchen Timer
-Electrical Requirements-
Power: 115V/60 Hz
Start-Up Amps: 2.56
Running Amps: 0.76
Energy kWh/year: 199

-MICROCHILL FEATURES-

-Refrigerator Features-
1 Adjustable Glass Shelf
1 Glass Crisper Shelf
2 Door Shelves
2-Liter Bottle Storage
1 In-Door Can Rack
Clear Crisper Drawer
Temperature Control
Automatic Defrost
Interior Light
Chill White Interior

-Freezer Features-
True 0 degree freezer
Manual Defrost
1 Ice Cube Tray

-Electrical Requirements-
Power: 120V/60 Hz
Power Output, Cook: 700 watts
Start-Up Amps: 8.5

Cycles Power from Fridge when Microwave is in use to conserve energy and amp consumption. Power is restored to fridge when microwave door is open. EPA Compliant R600a refrigerant



Meets Tier 1 specifications by using 30% less energy than the federal standard.

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MicroChill®



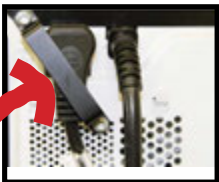
3.2 cu. ft. Dual USB Port MicroChill with Internal Smoke Sensor

www.collegeproducts.com
(712) 226-3250



199 kWh
HIGHEST EFFICIENCY
AVAILABLE!

Signature Features



Tamper-Resistant
Strap (UL Certified)



Dual USB Charging Station
Conveniently located on the front control panel
for easy access and quick charging.



-REFRIGERATOR FEATURES-

- 1 Adjustable Glass Shelf
- 1 Glass Crisper Shelf
- 2 Door Shelves
- 2-Liter Bottle Storage
- 1 In-Door Can Rack
- Clear Crisper Drawer
- Temperature Control
- Automatic Defrost
- Interior Light

-FREEZER FEATURES-

- True 0 degree freezer
- Manual Defrost
- 1 Ice Cube Tray

-ELECTRICAL REQUIREMENTS-

Power: 115V/60 Hz
Start-Up Amps: 2.56
Running Amps: 0.76
Energy kWh/year: 199

-MICROWAVE FEATURES-

- Stainless Steel Door Handle
- Dual USB Charging Station
- 2 - 2.0 Amp Ports
- Internal Smoke Sensor
- Electronic Control Panel
- One Touch Cooking Programs
- Kitchen Timer
- 6'7" Power Cord
- Available Color: Black

-CABINET FEATURES-

- Textured Finish
- Low Profile Recessed Handles
- Reversible Door Hinges
- 5'6" Power Cord
- Available Colors: Black

-ELECTRICAL REQUIREMENTS-

Power: 120V/60 Hz
Power Output, Cook: 700 watts
Start-Up Amps: 8.5

EXTERIOR DIMENSIONS

Height: 44 5/8"
Width: 18 9/16"
Width with door open 180°: 34 3/4"
Depth: 19 3/8"
Depth with door open 90°: 35 1/4"

-INTERIOR VOLUME-

3.2 cu. ft.
Fridge Volume: 2.3 cu. ft.
Freezer Volume: .90 cu. ft.

-INTERIOR DIMENSIONS-

Oven Capacity: 0.8 cu. ft.

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Meets Tier 1 specifications by
using 30% less energy than the
federal standard.